Catalogue no. 88F0006XIE — No. 006
ISSN: 1706-8967
ISBN: 0-662-36265-9

Working Paper

Science, Innovation and Electronic Information Division

Biotechnology Use and Development Survey: methodology, issues and responses

By Namatié Traoré, Ph.D

Science, Innovation and Electronic Information Division (SIEID)
7-A, R.H. Coats Building, Ottawa, K1A 0T6

Telephone: 1 800 263-1136

This paper represents the views of the author and does not necessarily reflect the opinions of Statistics Canada.

Statistics Canada Statistique Canada

Canada

Biotechnology Use and Development Survey: methodology, issues and responses

88F0006X1E2004006
ISSN: 1706-8967
ISBN: 0-662-36265-9

Science, Innovation and Electronic Information Division (SIEID)
7-A, R.H. Coats Building
Statistics Canada
Ottawa, ON K1A 0T6

How to obtain more information:
National inquiries line: 1 800 263-1136
E-Mail inquiries: infostats@statcan.ca

February 2004

Prepared by:

NAMATIE TRAORE, Ph.D
Economist/Statistician,
Science, Innovation and Electronic Information Division (SIEID)
Statistics Canada

ST-04-06

Contacts for more information

Science, Innovation and Electronic Information Division

Director Dr. F.D. Gault (613-951-2198)

Assistant Director Craig Kuntz (613-951-7092)

The Science and Innovation Information Program

Special Advisor, Science and Technology
Dr. Frances Anderson (613-951-6307)

Chief, Knowledge Indicators
Michael Bordt (613-951-8585)

Chief, Innovation, Technology and Jobs
Daood Hamdani (613-951-3490)

Special Advisor, Life Sciences
Antoine Rose (613-951-9919)

Science and Innovation Surveys Section

Chief, Science and Technology Surveys
Antoine Rose (613-951-9919)

FAX: (613-951-9920)

E-Mail: Sieidinfo@statcan.ca

Working Papers

The Working Papers publish research related to science and technology issues. All papers are subject to internal review. The views expressed in the articles are those of the authors and do not necessarily reflect the views of Statistics Canada.

Published by the authority of the Minister responsible for Statistics Canada

© Minister of Industry, 2004

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without prior written permission from Licence Services, Marketing Division, Statistics Canada, Ottawa, Ontario, Canada K1A 0T6.

The science and innovation information program

The purpose of this program is to develop **useful indicators of science and technology activity** in Canada based on a framework that ties them together into a coherent picture. To achieve the purpose, statistical indicators are being developed in five key entities:

- **Actors**: are persons and institutions engaged in S&T activities. Measures include distinguishing R&D performers, identifying universities that license their technologies, and determining the field of study of graduates.
- **Activities**: include the creation, transmission or use of S&T knowledge including research and development, innovation, and use of technologies.
- **Linkages**: are the means by which S&T knowledge is transferred among actors. Measures include the flow of graduates to industries, the licensing of a university's technology to a company, co-authorship of scientific papers, the source of ideas for innovation in industry.
- **Outcomes**: are the medium-term consequences of activities. An outcome of an innovation in a firm may be more highly skilled jobs. An outcome of a firm adopting a new technology may be a greater market share for that firm.
- **Impacts**: are the longer-term consequences of activities, linkages and outcomes. Wireless telephony is the result of many activities, linkages and outcomes. It has wide-ranging economic and social impacts such as increased connectedness.

The development of these indicators and their further elaboration is being done at Statistics Canada, in collaboration with other government departments and agencies, and a network of contractors.

Prior to the start of this work, the ongoing measurements of S&T activities were limited to the investment of money and human resources in research and development (R&D). For governments, there were also measures of related scientific activity (RSA) such as surveys and routine testing. These measures presented a limited picture of science and technology in Canada. More measures were needed to improve the picture.

Innovation makes firms competitive and we are continuing with our efforts to understand the characteristics of innovative and non-innovative firms, especially in the service sector that dominates the Canadian Economy. The capacity to innovate resides in people and measures are being developed of the characteristics of people in those industries that lead science and technology activity. In these same industries, measures are being made of the creation and the loss of jobs as part of understanding the impact of technological change.

The federal government is a principal player in science and technology in which it invests over five billion dollars each year. In the past, it has been possible to say only *how much* the federal government spends and *where* it spends it. Our report **Federal Scientific Activities, 1998 (Cat. No. 88-204)** first published socio-economic objectives indicators to show *what* the S&T money is spent on. As well as offering a basis for a public debate on the priorities of government spending, all of this information has been used to provide a context for performance reports of individual departments and agencies.

As of April 1999, the Program has been established as a part of Statistics Canada's Science, Innovation and Electronic Information Division.

The final version of the framework that guides the future elaboration of indicators was published in December, 1998 (**Science and Technology Activities and Impacts: A Framework for a Statistical Information System,** Cat. No. 88-522). The framework has given rise to **A Five-Year Strategic Plan for the Development of an Information System for Science and Technology** (Cat. No. 88-523).

It is now possible to report on the Canadian system on science and technology and show the role of the federal government in that system.

Our working papers and research papers are available at no cost on the Statistics Canada Internet site at http://www.statcan.ca/cgi-bin/downpub/research.cgi?subject=193.

Table of Contents

I Background 7
II Defining biotechnology and an Innovative Biotechnology Firm: Issues and Responses 8
2.1 What is Biotechnology? 8
2.2 What is an innovative biotechnology Firm? 8
III Target population, Sampling Unit 9
3.1 Target Population 9
3.2 Sampling Unit 10
3.3 Data strata 11
3.4 Respondent Selection and Respondent Burden 11
3.4.1 Respondent Selection 11
3.4.2 Respondent Burden 12
3.5 Other exclusions from the survey 12
IV Data Quality, Data Collection, Edit and Imputation 13
4.1 Data Quality 13
4.1.1 Relevance of the data 13
4.1.2 Accuracy of the data 13
4.1.3 Timeliness of the data 13
4.1.4 Accessibility to the data 13
4.1.5 Interpretability 14
4.1.6 Coherence 14
4.1.7 Response Rates 14
4.2 Data Collection, Edit and Imputation 14
4.2.1 Data Collection and Edit 15
4.2.2 Imputation techniques and Imputation rates 15
4.3 Estimates 16
V Brief Description of the Surveys 17
5.1 19997 Biotechnology Firm Survey - 1997 17
5.2 Biotechnology Use and Development Survey – 1999 18
5.3 Biotechnology Use and Development Survey – 2001 19
VI Changes in the Survey Methodology and their Impacts on the Estimates 20
6.1 1997 Biotechnology Firm Survey Vs 1999 BUDS 20
6.2 1999 BUDS Vs 2001 BUDS 21
6.3 Impacts of the Change in Survey Methodology on the Estimates 22
VII Lessons Learned 22
7.1 Defining biotechnology 22
7.2 Defining an Innovative biotech firm 22
7.3 Targeting the right population 23
7.4 Measuring Biotechnology Employment 23
VIII Conclusion 24
References 25
How to order catalogued publications 27
Appendix 1: Biotechnology Firm Survey – 1997
Appendix 2: Biotechnology Use and Development Survey – 1999
Appendix 3: Biotechnology Use and Development Survey – 2001; First phase questionnaire
Appendix 4: Biotechnology Use and Development Survey – 2001; Second phase questionnaire

ELECTRONIC PUBLICATIONS AVAILABLE AT
www.statcan.ca

Biotechnology Use and Development Survey: methodology issues and responses

I Background

Scientific breakthroughs in genomics, proteomics and bioinformatics have given an "élan" to the development of biotechnology activities. This is apparent in 1) the increasing number of innovative firms in biotechnology and 2) the rise in the leading indicators of biotechnology activities, namely, the number of biotechnology employees, biotech revenues, the number of products at both developmental and production stages, and R&D expenditures.

Collecting sound data on biotechnology is a real challenge (Rose, 2000). Biotechnology is a pervasive technology used in several industrial sectors. Second, unlike most industrial activities where "physical" components are assembled to obtain the end product, biotechnology is a set of techniques that are used in current operation or to develop new products and processes.

In 1996, the first ever survey of biotechnology by a national statistical agency was undertaken by Statistics Canada. Entitled "Survey of Biotechnology Use in Canadian Industries – 1996", it aimed at assessing the use of biotechnology by selected Canadian industries: Aquaculture and Forestry, Agro-industry, Wood, Pulp and Paper, Coal/Oil/Gas, and Chemicals. Strong indications of widespread biotechnology utilization by the Canadian industry gave rise to the Biotechnology Firm Survey - 1997. This was followed by the 1999 Biotechnology Use and Development (BUDS) and the 2001 BUDS. These last three surveys went beyond measuring the use of biotechnologies to emphasize the development of new products and processes using biotechnology. The objective of the extension in the scope of biotech surveys was two-fold: 1) to satisfy the information needs of both policy makers and the industry as they related to biotechnology adoption, development and diffusion; and, 2) to document and measure the characteristics of Canadian firms that are using biotechnology to develop new products and processes.

This paper explains the methodologies used in these surveys, the problems encountered, the responses to these problems, and the lessons learned. The organization of the paper is as follows: definitional issues will be presented in the second section; the target population and the sampling issues, as they relate to the management of response burden, in section 3; data quality in section 4; a brief description of the 1997 Biotechnology Firm Survey, the 1999 and the 2001 BUDS in section 5; issues related to the change in the survey methodology, as well as their impacts on the estimates, in section 6; the lessons learned in section 7; and the conclusions in section 8.

II Defining biotechnology and an Innovative Biotechnology Firm: Issues and Responses

2.1 What is Biotechnology?

Because of its pervasive nature, biotechnology is best thought of as a cross-sectoral or cross-industrial activity, rather than a sector or an industry. In fact, as a set of scientific techniques, it has multiple usage across sectors and industrial fields and does not fall under any single code of the North American Industry Classification System (NAICS)[1] (Statistics Canada, 1997). Consequently, defining biotechnology statistically is a challenge. Most of the earlier definitions are found in Rose (2000).

Statistics Canada uses a double-definition strategy: a "normative" or single definition and an "operational" or list-based definition. According to the single definition biotechnology is the "*application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes*"[2].

The problem associated with the use of such a general definition is that the interpretation of the definition can vary broadly and is left to the respondents. To help with the interpretation of this definition, a list-based approach was developed. The use of a list was preferred by respondents during questionnaire testing as being more precise.

In 1997, the list-based definition included 17 specific biotechnologies grouped under 3 main blocks (Appendix1): DNA-based biotechnologies; Biochemistry/Immunology; and Bioprocessing-based biotechnologies. The same grouping was used in the 1999 BUDS, except that the last block was divided into Bioprocessing based biotechnologies and Environment (Appendix 2). In the 2001 BUDS, the list-based definition comprised 19 specific biotechnologies in 5 main blocks (Appendix 4): DNA – the coding, Proteins and Molecules – the Functional Blocks, Cell and Tissue Culture, and Engineering, Process Biotechnologies, Sub-cellular Organisms. The provisional definition of biotechnology adopted by the OECD used a similar structure (OECD, 2003).

2.2 What is an innovative biotechnology Firm?

Biotechnologies are techniques or set of techniques. Firms may use these techniques within their production processes for different reasons. For example, biotechnologies may be used for environmental purposes. Other firms may use them to develop products and processes. Many firms in this latter group, the main focus of the Biotechnology Use and Development Surveys, have no product on the market. For example, in 1997, 67% of the

---

[1] This is why, at Statistics Canada, the term "biotechnology activities" instead of "biotechnology sector" or "biotechnology industry" is used to describe the activities related to the use of biotechnology techniques to develop new products/processes.

[2] Under the leadership of Canada, the provisional single definition from the OECD to be used in the 2003 BUDS is as follows "*the application of S&T to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services*".

firms had no product on the market . This figure was 47% in 1999 and 52% in 2001. Thus, defining an innovative biotechnology firm solely in terms of the number of products on the market would have excluded a great number of firms. This problem was overcome by defining an innovative biotech firm as "a firm developing new products and processes that require the use of biotechnologies".

In practice, an innovative biotech firms is identified by doing two things. First, respondent firms have to be using at least one biotechnology. Second, this use has to be geared toward developing new products or processes. This latter condition is met when a firm reports having at least one product or process at any developmental stage, in production, approved, or on the market that require the use of biotechnologies. More often than not, such firms have employees dedicated to biotechnology activities and are conducting biotechnology related R&D.

An innovative biotechnology firm is thus defined in terms of its ability to use biotechnologies in its production process (process innovation), rather than having introduced new products on the market (product innovation). In this respect, the definition used is more in line with the OECD/EUROSTAT's definition of a process innovation, i.e. "the use of a technologically new or significantly technologically improved processes within a production process" (OECD/EUROSTAT, 1997).

III Target population, Sampling Unit

3.1 Target Population

The target population of the biotechnology surveys are all firms that use biotechnology in their production process or to develop products or processes. These firms are not found under any single NAICS code. Thus reaching them requires selecting specific NAICS codes. The choice of these NAICS codes is based on the probability of biotechnology use, past experiences, and expert opinion. It involves Statistics Canada, industry experts, and federal departments such as Industry Canada, and Agriculture and Agri-food Canada. Firms that provide only biotechnology related services are excluded.

The 1997 Biotechnology Firm survey was based on 475 firms the name and addresses of which were obtained from Industry Canada, the 1998 Canadian Biotechnology Directory maintained by Contact Canada (Contact Canada, 1997), and the Statistics Canada Industrial R&D survey (Traoré, 2001; Laroche, 2001). The 1999 and the 2001 BUDS included both a "must-take-all" list of firms put in place using the 1997 methodology and a sample of firms from Statistics Canada's Business Register (BR). The specific NAICS codes from which the sample of firms were drawn are presented in Table 1.

Table 1: Selected NAICS from which the Survey Sample was drawn, 1999, 2001

NAICS	Associated Industry
1125	Animal Aquaculture
1132	Forest Nurseries and Gathering of Forest Products
2111	Oil and Gas Extraction
2122	Metal Ore Mining
2123	Non-Metal Mineral Mining and Quarrying
311	Food Manufacturing
3121	Beverage Manufacturing
31311[(a)]	Fibre, Yarn and Thread Mills
3221	Pulp, Paper and Paperboard Mills
3222[(a)]	Converted Paper Product Manufacturing
32411	Petroleum Refineries
325	Chemical Manufacturing
3254	Pharmaceutical and Medicine Manufacturing
4145	Pharmaceuticals, Toiletries, Cosmetics and Sundries Wholesalers-Distributors
4183	Agricultural Supplies Wholesalers-Distributors
5417[(a)]	Scientific Research and Development Services
6215[(a)]	Medical and Diagnostic Laboratories

Sources: Statistics Canada 1997. North American Industry Classification Systems, Cat.No. 12-501-XPE,
Note: (a) refers to NAICS codes that were surveyed only in 2001.

3.2 Sampling Unit

Two types of firms are found in the Biotechnology surveys: single location firms and multiple location firms. The former group is made of firms for which the enterprise and the establishment as defined by Statistics Canada are the same. The latter group concerns all the enterprises with multiple establishments. In some cases, not all these establishments are in the same NAICS code. In other words, some multiple location firms have more than one NAICS code.

The need for any Statistics Canada's survey to produce data at the provincial and territorial levels was an overriding reason for the choice of the sampling unit. Thus, for the multi-establishment firms, all the establishments in a given province or territory were grouped to form a single unit. The NAICS code assigned to this new statistical unit is that of the establishment with the largest share of gross business income (GBI). In cases where two or more establishments have the same GBI, the assigned NAICS code is randomly chosen among these units (Morin et al., 2001; Lavigne, 2003). Consequently, the sampling unit is the "provincial" enterprise[3].

[3] The "provincial" enterprise as a sampling unit was also used in the 1999 Innovation Survey. Because of increased demand by data users for data at the Census Agglomerations (CA) and the Census Metropolitan Areas (CMA) levels, the survey on Innovation in Services and the 2003 Biotechnology Use and Development surveys will be using the "establishment" as the sampling unit. This refers to an operation, in contrast to the "provincial" enterprise which is the "sum" of all the operations of a given firm in a province.

3.3 Data strata

Producing estimates at the provincial and territorial levels is an important requirement for all the surveys at Statistics Canada. Consequently, province/territory was an important dimension in stratifying the sample. These dimension has 12 levels: 10 provinces and 2 territories[4]. Two other dimensions, namely, the NAICS code (industrial sector) and firm size were deemed appropriate levels at which to produce estimates. The former is made of the 13 NAICS codes shown in table 2 for the 1999 BUDS; and 17 NAICS codes in the 2001 BUDS (Table 1). Size has 3 levels, small, medium, and large. As shown in Table 2, in 1999, this resulted in 468 (= 12*13*3) different strata and in 2001, 612 strata (=12*17*3).

Given that 1) Statistics Canada has no single standardized definition of "small businesses" and 2) most innovative biotechnology firms are years away from any revenues, it was not deemed appropriate to define size in terms of revenues. Instead, it was decided to use the number of employees in any given firm. As a result, small biotech firms are all the firms with 50 employees or fewer, medium-sized firms are firms that have between 51 and 150 employees, and large firms have over 150 employees. The choice of these size thresholds came about in the 1997 Biotechnology Firm Survey. Statistics Canada wanted to retain some measure of comparability with other existing sources of biotechnology data in Canada. Subsequently, to enable comparison of the estimates from one survey to the other, these thresholds were retained and continue to be used[5]. We use Statistics Canada's standard classes in any subsequent surveys.

Table 2: Number of Strata Used in the 1999 and 2001 BUDS

	1999	2001
Number of provinces and territories[(a)]	12	12
Number of industries (NAICS)	13	17
Number of firm size categories	3	3
Total	**468**	**612**

Source: Statistics Canada, BUDS 1999 & 2001
Note:
[(a)] Nunavut was not surveyed

3.4 Respondent Selection and Respondent Burden

3.4.1 Respondent Selection

Respondent selection was undertaken based on two main considerations: to reach the target population; and, to minimize respondent burden. To this end, 1) GBI, R&D expenditures and number of employees were used as selection criteria, 2) industries were

[4] Nunavut was not surveyed.
[5] Size classes in the BR are less than 50 employees, 50 to 149 employees and 150 employees and up. While the use of different size classes in the Biotechnology surveys results in an insignificant difference in the results, the BR classes will be used as soon as resources are available to reanalyze the earlier surveys.

surveyed at levels other than 4-digits, and 3) small firms with 50 employees or fewer were not rotated out of the survey even after being included in two consecutive surveys.

Based on results from the 1997 Biotechnology Firm Survey, 65% of firms conducting 35% of all R&D in biotechnology would have been excluded had the GBI been the only selection criterion. This problem was overcome by using the GBI along with the number of employees and the amount of R&D expenditures to select respondents from both the BR and the must-take-all list.

Firms with less than 5 employees and spending less than $100,000 in R&D expenditures. These firms contribute less than 1% to both expenditures in R&D and to the number of new products/processes. Thus, the exclusion does not result in any noticeable bias in the estimates. In addition, it reduces respondent burden.

Furthermore, as shown in table 1, even though most industries were surveyed at the 4-digit level, some industries such as Food Manufacturing (NAICS 311) and Chemical Manufacturing (NAICS 325) were surveyed at the 3-digit level. Petroleum Refineries was surveyed at the 5-digit level (NAICS 32411).

The universe of firms involved in using biotechnology to develop new products and processes was made of 282 firms in 1997, 358 in 1999, and 375 in 2001. Over 70% of these are small firms with 50 employees or fewer. Thus, rotating these firms out of the sample after two years in the survey would invalidate the estimates.

3.4.2 Respondent Burden

Based on respondent reports, 90 minutes were necessary to answer to the full 1997 Biotechnology Firm Survey. In the 1999 BUDS, a multi-stage screening process was implemented. It helped in reducing the response burden by progressively screening out firms based on the extent of their biotechnology activities. Thus, the time required to fill in the survey was 15 minutes for non-users of biotechnology, 30 minutes for users, and 90 minutes for innovative biotech firms. In 2001, the pre-contact questionnaire could be filled in within 5 minutes. Applying the same screening technique as in 1999, in the 2001 BUDS, users were able to complete the full questionnaire of the second phase within 30 minutes and innovative firms, within 90 minutes.

3.5 Other exclusions from the survey

In addition to small firms with less than 5 employees and spending less than $100,000 in R&D, additional exclusions from the surveys include not-for-profit organizations, universities, government laboratories, and hospitals. Also excluded from the survey are contract research organizations (CROs) that provide only services to biotechnology firms. These entities, even though related to biotechnologies through the provision of R&D services and the creation of spin-off firms, do not meet the main criterion of biotechnology surveys, i.e. to provide information on firms that use biotechnology to develop new products and processes.

IV Data Quality, Data Collection, Edit and Imputation

In all the biotechnology surveys, the data quality was insured by taking into account and applying throughout the survey process all 6 dimensions of data quality control at Statistics Canada, namely, relevance of data collected, their accuracy, their timeliness, their accessibility, their interpretability, and their coherence (Statistics Canada, 2003; 2002; 1998).

4.1 Data Quality

4.1.1 Relevance of the data

To insure the relevance of the data to policy makers, industry and analysts, all the questionnaires were designed by the Life Sciences Unit of the Science, Innovation and Electronic Division at Statistics Canada in collaboration with industry experts and federal stakeholders such as Industry Canada and Agriculture and Agri-Food Canada. Also, as shown below, the relevance of the data was insured by making the survey results and data available to users in a timely manner.

4.1.2 Accuracy of the data

Accuracy of data collected was insured by conducting cognitive interviews with small samples of respondents in both official languages with help from the Questionnaire Design Resource Centre (QDRC). Feedbacks and comments from these interviews were integrated into the questionnaire to improve the design and most importantly, to insure that the questions were well understood by respondents.

A knowledgeable person in the respondent firms, such as an R&D manager or a production manager, was asked to answer the questionnaire. Such individuals were able to provide with accuracy the type of information requested in the questionnaires.

As shown below, further checks into the accuracy of the data were conducted by analyzing non-response rate. Furthermore, the sampling process was specifically designed to reach the target population.

4.1.3 Timeliness of the data

To date, all the biotech surveys, from the inception period to the publication of the results, have been completed on time, i.e. within a year time. For example, the consultation process for the 2001 BUDS began in the Fall of 2001 and the survey results were published in the Fall of 2002.

4.1.4 Accessibility to the data

Data from the biotechnology surveys are made available to users through a number of venues, including the sharing of data and statistics with provincial statistical institutions. Other venues include the Facilitated access program whereby researchers from academia are given access to the survey data to conduct research on their own topics.

Analytical and working papers by staff of the Life Sciences section of the Science, Innovation and Electronic Information Division are published in scientific journal or made available on the web-site of Statistics Canada. Some of these studies are also presented in international conferences. These are in addition to descriptive tables provided to different stakeholders such as Industry Canada and Agriculture and Agri-Food Canada.

4.1.5 Interpretability

All the Biotechnology surveys are registered in the Integrated Metadatabase (IMDB). The information available concern the definitions of the underlying concepts, the classifications used, the methodology of data collection and processing, and indications of the accuracy of the data and other related statistical information. These records are available to data users on Statistics Canada web-site.

4.1.6 Coherence

Coherence in the data is insured by using the same definitions from across surveys, as well as the same classifications. The target population has remained the same so as the data collection process.

There was a methodology change between the 1997 Biotechnology Firm survey and the 1999 Biotechnology Use and Development survey. However, as shown below, this change had minor effects on the estimates.

4.1.7 Response Rates[6]

Of the 475 firms that were sent the 1997 Biotechnology Firm Survey, 392 filled out and returned the questionnaires, resulting into an overall response rate of 83%. The 1999 BUDS was mailed to 3,377 firms. The response rate was 66% or 2,229 returned questionnaires. In the 2001 BUDS, the first phase or "pre-contact" questionnaire was mailed in the Winter of 2002 to a sample of 11,262 firms. The response rate was 70%. The full or second stage questionnaire was mailed in the Spring of 2002 to 900 firms and had a response rate of 84%.

In each of the surveys, analyses of non-respondents were conducted. No evidence of bias was found as these analyses showed that non-respondents had the same characteristics as respondents to the surveys. Consequently, estimates from the surveys provide a clear picture of the biotechnology universe for each period and are a valid representation of the Canadian biotechnology firm population in each year.

4.2 Data Collection, Edit and Imputation

[6] The detailed response rates are found in tables in section 5 below

4 2.1 Data Collection and Edit

The data collection was done by staff of the Science, Innovation and Electronic Information Division. The surveys were direct and mandatory, meaning that the data were requested directly from respondents who were required to provide the requested information. The surveys were mail-out/mail back surveys. Reminder cards and telephone calls were used for subsequent follow-ups.

Post collection edits were undertaken in collaboration with the Business Survey Methodology Division (BSMD) to insure consistency in the data. These edits were applied to complete questionnaires. In 1997, a questionnaire was considered completed when questions 2, 3, 5 and 7 (Appendix 1) were answered. In 1999, it referred to one with responses to questions 1, 5, 7, and 13 (Appendix 2); and in 2001, it applied to a questionnaire with answers to questions 1, 4, 9, 10, and 16 (Appendix 4)[7].

4.2.2 Imputation techniques and Imputation rates

Two imputation techniques were used, namely, deterministic and hot-deck. Deterministic or deductive imputation was used in cases where logical relations existed among variables. In such cases, the "revealed" behavior of the respondent unit in a preceding question influenced the response to a subsequent question(s). Consequently, the revealed answer was used to impute the logical value of the missing response. Examples of such related questions were skip pattern questions. For instance, in the 2001 BUDS, in question 5a, respondents were asked if they had any unfilled biotechnology position. Those that answered "NO" to that question were asked to skip to question 5b. Otherwise, they were to fill-in a table. In cases where the table was filled and question 5a was not either answered or the given answer was "NO", the response was changed to "YES".

In cases where deterministic imputation did not apply, hot-deck imputation was used. It consisted of choosing a random donor from the same homogenous response group as the non-respondent, starting with the smallest, i.e. Province/NAICS/Size. For example, to find a donor for a small firm active in Agriculture in Quebec, the search would start in the Quebec/Agriculture/Small response group. If no donor is found in this group, the response group is extended to Province/NAICS. This process continues until a donor is found.

Overall, the imputation rates, obtained by dividing the number of imputed respondents to a question by the total number of respondents, were low for all three biotechnology surveys: on average 3.7% in 1997, 12.9% in 1999 and about 7% in 2001. For the 1997 Biotechnology Firm Survey, the rates of imputation range from 0 for a series of questions to a high of 5.3% for Q8. In the 1999 BUDS, except for Q11, i.e. where the imputation rate was 35%, all other questions had a rate of imputation between 0, for Q2, and 19.5%

[7] In all the cases, these questions referred to 1) the use of biotechnologies in either current production or for environmental purposes, 2) the presence in the firm of employees dedicated to biotechnology, 3) the development of products/processes using biotechnologies, 4) having biotechnology products/processes at either developmental or approved/production stages, and 5) conducting biotechnology R&D.

for Q13. As for the 2001 BUDS, the rates range from 1.9% to a high of 18.3%. The imputation rates for "quantitative" questions were quite low, 2.9% for Q4, i.e. Human resources, .8% for Q10, biotechnology products, 7% for Intellectual Properties, 3.8% for Capital raised, 4.8% for Exports and Imports question (Table 3).

Table 3: Imputation rates, Biotechnology Firm Survey – 1997, BUDS 1999, BUDS 2001

Questions	Imputation rates (%)		
	Biotechnology Firm Survey - 1997	***BUDS - 1999***	***BUDS - 2001***
Q1	1	7.21	6.70
Q2	5.19	0	7.74
Q3	0	15.13	8.96
Q4	2.75	15.76	2.95
Q5	9	13.62	7.98
Q6	8	16.83	5.99
Q7	0	12.89	5.34
Q8	5.20	1.46	9.29
Q9	0	16.38	8.99
Q10	10	16.7	.79
Q11	0	34.96	17.99
Q12		16.59	8.80
Q13		19.45	3.16
Q14			6.98
Q15			10.18
Q16			7.35
Q17			8.96
Q18			2.57
Q19			9.47
Q20			1.98
Q21			1.98
Q22			3.49
Q23			3.81
Q24			12.38
Q25			18.26
Q26			4.77
Q27			1.93
Q28			9.52
Q29			9.25

Source: Statistics Canada

4.3 Estimates

Estimates from surveys are used to produce population estimates. This requires that the sample weights of the responding units be adjusted to take into account non-respondents.

This procedure was applied to all the biotechnology surveys. All the estimates were produced using the Generalized Estimation System (GES) in the Statistical Analysis System (SAS) computer package (Statistics Canada, 2002). Estimates were produced at the firm size, industry and province/territory levels. However for this latter level, to meet confidentiality requirements, no estimates could be produced separately for the Atlantic provinces. It was then decided to produce a single estimate for this region, under Atlantic. Similarly, no estimates could be produced for the two territories that were surveyed, namely, Yukon and the Northwest Territories.

Publication of the estimates follows Statistics Canada's guidelines in this matter (Table 4). In cases where the estimates were either unreliable because of high coefficient of variations (CV), i.e. CV above 50%, or did not meet the confidentiality requirements of the Statistics Act, they were suppressed and replaced by the appropriate symbol (Table 4). Whenever the estimates had a low reliability, i.e. a CV between 30% and 50%, they were marked with an E to warn data users that they should be used with some caution (Table 4).

Table 4: Symbols Used When Publishing the Estimates

Symbol	Meaning
.	Not available for any reference period
..	Not available for a specific reference period
...	Not applicable
p	Preliminary
r	Revised
x	Suppressed to meet the requirements of the Statistics Act
E	Use with caution, (CV between 30% and 50%)
F	Too unreliable to be published, (CV more than 50%).

Source: Statistics Canada

V Brief Description of the Surveys

5.1 1997 Biotechnology Firm Survey - 1997

The 1997 Biotechnology Firm Survey was based on a list of 475 firms[8]. Of these, 138 were out of scope, 44 were out of business, 51 could not be reached or refused to answer the questionnaire, 32 did not return any questionnaire and 210 provided the requested data (Table 5). These resulted in 392 returned questionnaires of 83% survey response rate. After accounting for non-responses and applying post-stratification techniques, it was estimated that 282 firms constituted the core of Canadian biotechnology activities in 1997.

[8] More information on the 1997 Biotechnology Firm Survey may be found in Traoré (2001) and Laroche (2001).

Table 5: Response Categories and Corresponding Number of Respondents, Biotechnology Firm Survey – 1997

Response categories	Number of respondents
Out of scope	138
Out of business	44
Could not be reached or refused to answer	51
Provided requested information	210
Non-response	32
Total	**475**

Source: Statistics Canada, Biotechnology Firm Survey - 1997

5.2 Biotechnology Use and Development Survey – 1999

Drawing upon the 1997 Biotechnology Firm Survey, the 1999 BUDS contained additional questions. They related to 1) the barriers to using biotechnologies, 2) the sources of information on biotechnology, 3) the benefits from using biotechnology, and 4) Intellectual property (Appendix 2).

The sample was made of 3,377 firms of which 2,999 came from the BR and 378 from a must-take-all list of firms provided by Statistics Canada and industry experts. Sixty two (62) of these firms were out of business, 40 were out of scope, 13 had either merged with or were acquired by other firms, 123 could not be reached, 20 refused to answer the questionnaire, 1,982 filled out and returned the questionnaire, and no response was received from 1,148 firms (Table 6). Of the 1,982 returned questionnaires, 1,568 were not involved in biotechnology, 192 were biotechnology users, and 223 were classified as innovative firms. As shown in Table 7, 35 of the 223 innovative firms came from the BR and 188 from the Must-take-all list. Likewise,165 of the users came from the BR and 27 from the Must-take-all list.

After accounting for non-respondents, it was estimated that 358 firms made up the population of innovative biotechnology population in Canada in 1999.

Table 6: Response Categories and Corresponding Number of Respondents, Biotechnology Use and Development Survey – 1999

Response categories	Number of respondents
Out of scope	40
Out of business	62
Could not be reached	123
Refused to answer	20
Merger/Acquisition	13
Provided requested data	1,982
Non-response	1,148
Total	**3,377**

Source: Statistics Canada, Biotechnology Use and Development Survey – 1999

Table 7: Distribution of Innovative, Users among Respondents in the BR Sample and the Must-take-all List, 1999

Origin	Status		Total
	Innovative	*Users*	
Sample from the BR	35	165	**200**
Must-take-all	188	27	**215**
Total	**223**	**192**	**415**

Source: Statistics Canada, 1999 BUDS

5.3 Biotechnology Use and Development Survey – 2001

The 2001 BUDS was done in two phases. The pre-contact or first phase questionnaire was a one page questionnaire (Appendix 3) and was mailed out to 11,262 firms from the BR. It was intended to identify firms that used biotechnology as part of their activities. Seven thousand eight hundred and eighty three (7,883) firms returned the questionnaire. Of these, 512 firms or 6.5% reported using or developing biotechnology products/processes in their daily activities.

This list of 512 firms was supplemented by a "must-take-all" list of 388 firms. The list was constructed using the following sources: Statistics Canada, Agriculture and Agri-Food Canada. The resulting 900 firms where sent the full questionnaire in the Spring of 2002 (Appendix 4). Twenty three (23) were out of scope, 10 were out of business, 45 had either merged with or been acquired by another firm, 24 could not be reached, 9 refused to answer the questionnaire, no questionnaire was received from 143 (Table 8). Of the 646 completed questionnaires, 334 were not involved in biotechnology, 59 were biotechnology users, and 253 were involved in developing biotechnology products/processes. As shown in Table 9, 65 of the innovative came from the BR and 188 came from the Must-take-all list. Forty one (41) of the users came from the BR and 18 from the Must-take-all list.

Taking into account non-respondents, estimates from this second stage indicated that the core of Canadian biotechnology was made of 375 innovative firms in 2001.

Table 8: Response Categories and Corresponding Number of Respondents, Biotechnology Use and Development Survey – 2001

Response categories	Number of respondents
Out of scope	23
Out of business	10
Could not be reached	24
Refused to answer	9
Merger/Acquisition	45
Provided requested data	646
Non-response	143
Total	**900**

Source: Statistics Canada, Biotechnology Use and Development Survey - 2001

Table 9: Distribution of Innovative, Users among Respondents in the BR Sample and the Must-take-all List, 2001

Origin	Status		Total
	Innovative	*Users*	
Sample from the BR	65	41	**106**
Must-take-all	188	18	**206**
Total	**253**	**59**	**312**

Source: Statistics Canada, 2001 BUDS

VI Changes in the Survey Methodology and their Impacts on the Estimates

6.1 1997 Biotechnology Firm Survey Vs 1999 BUDS

As stated earlier, the 1997 Biotechnology Firm survey was based on a list of 475 firms (Traoré, 2001; Laroche, 2001). The 1999 BUDS was a combination of a sample of 2,999 firms from the BR and a must-take-all list of 378 firms (McNiven 2001 a&b). Altogether, they returned 2,229 questionnaires of which 1,971 came from the BR and 258 from the must-take-all list. As shown by figures in Table 4, 188 of these 258 firms from the must-take-all list were classified as innovative biotech firms. This amounts to 84% of the 223 firms on which the 1999 biotechnology population estimates were based. Comparatively, 35 firms or 16% of the innovative firms came from the BR sample. In other words, 16% of the 223 innovative firms would not have been accounted for had the must-take-all list been the sole source of firms surveyed in 1999. When the population weights are taken into account, this translates into one third (1/3) of the 358 innovative firms in 1999 coming from the BR and two thirds (2/3) from the must-take-all list. Applying these percentages to the 76 additional firms accounted for in 1999, gives 25 firms from the BR and 51 from the must-take-all list. Thus, 25 additional firms have been identified by the sampling procedure. Put differently, had the 1997 survey methodology been applied in 1999, this would have resulted in an underestimation of the biotechnology firm population by 25 firms.

Since these 76 additional firms represent a 27% increase in biotech firm population over the 1997-1999 period, the actual impact of the change in the survey methodology on the change in any biotechnology activity indicator is 27%*(1/3) = 9%. For biotechnology leading indicators, this implies that $121 million of the $1.35 billion increase in biotech revenues are the arte-fact of the change in the survey methodology; so are $30 million of the $333 million increase in biotech R&D, $37 million of the $407 million increase in biotech exports, 119 employees in the 1,324 decrease in biotech employment, $151 million of the $1.68 billion increase in the amount of capital raised, and 779 products in the 8,650 increase in the total number of biotech products (Table 10).

Comparison between the list of firms in 1997 and the must-take-all list in 1999 shows: 1) 81% of the 258 must-take-all firms that returned their questionnaires in 1999 were from the 1997 survey and 2) all the 388 firms on the must-take-all list in 1999 were from the same NAICS as firms in the 1997 survey. Thus, the 1997 list of firms and the 1999 must-take-all list are two samples from the same population. Consequently, they are representative samples of the same population.

Table 10: Share of the Change in the Leading Biotechnology Activity Indicators Attributed to the Change in the Survey Methodology between 1997 and 1999

Indicators	Actual Impact
Number of innovative biotech firms	25
Biotech R&D	$30 million
Biotech Revenues	$121 million
Biotech employment	(119) employees[(a)]
Biotech Exports	$37 million
Biotech products	779 products
Amount of capital raised	$151 million

Source: Statistics Canada, 1997 Biotechnology Firm Survey and 1999 BUDS

Note:

[(a)] Implies that the figure is negative

6.2 1999 BUDS Vs 2001 BUDS

No methodology changes occurred between the last two surveys, i.e. 1999 and 2001 surveys, only the population surveyed in 2001 was larger and the "pre-contact" was done by mail. Like for the 1997 and 1999 surveys, the must-take-all list in 2001 came from the same NAICS as that of 1999. Thus, the two must-take-all lists are representative of the same population. Also all the NAICS codes of 1999 were surveyed in 2001 and represented 80% of the sample in the 2001 BUDS. The remaining 20% came from 4 new NAICS codes, namely, 31311, 3222, 5417, and 6215 (Table 1). The first NAICS code contributed nothing to the final count of innovative firms and the second contributed only one unit. In other words, the increase in the sample in 2001 came principally from the same population surveyed in 1999. Furthermore, this larger population size resulted in 17 additional firms, less than 5% of the estimated biotechnology firm population in 2001.

6.3 Impacts of the Change in Survey Methodology on the Estimates

Given the aforementioned facts, changes in survey methodology resulted in 25 additional firms being captured in 1999. In other words, had the methodology remained unchanged between 1997 and 1999, the biotechnology firm population would have been underestimated by 25 firms or 7%. However, as shown in Table 10, the impact of this under-estimation on the key biotechnology activity indicators is small. Between 1999 and 2001, the larger sample size resulted in 17 additional firms, less than 5% of the 2001 biotech firm population in 2001.

VII Lessons Learned

7.1 Defining biotechnology

Comments from respondents in the cognitive interviews during the questionnaire testing showed that the strategy consisting in using a double-definition of biotechnology is very helpful. Even though concise, the wording of the single definition was not clear to all the respondents. In fact, some respondents were not sure of the meaning or interpretation of key words such as science, living organisms or parts of living organisms, innovative manner. In contrast, the list based-definition which used specific biotechnologies grouped under different domains, was well understood. Second, by so doing, it allowed them to know whether or not their activities fell into the biotechnology domain. Otherwise, they could quickly exit the survey and save time. Thus, an additional advantage of the double-definition strategy was to minimize respondent burden.

7.2 Defining an Innovative biotech firm

According to the Oslo Manual (OECD/EUROSTAT, 1997), a technological product/process (TPP) innovating firm is "one that has implemented technologically new or significantly technologically improved products or processes". A TPP innovation has been implemented if "it has been introduced on the market (product innovation) or used within a production process (process innovation)".

Given that most firms in the target population of the Biotechnology Use and Development surveys do not have any product on the market, and given Biotechnology is best thought as a set techniques which may be used by firms in their production processes, an innovative biotech firms has been defined along the lines of process innovation. This allows to capture the target population of the biotech surveys.

7.3 Targeting the right population

Biotechnology is a cross-sectoral activity that cannot be classified under any single NAICS code. Two things were done to solve this problem. NAICS codes where the use of biotechnology was probable were selected. Then, within these NAICS, care was taken to insure that only innovative biotechnology firms, i.e. firms are actively involved in using biotechnologies to develop new biotechnology products and processes are captured.

To this end, a screening process was put in place. First and foremost, respondents have to be using at least one of a series of biotechnologies. Second, they have to be using biotechnologies to develop new products and processes. This latter condition implies that the firm has at least one product or process in development, in production, or on the market. Only respondents that fulfilled all these conditions were classified as innovative biotechnology firms.

Firms with biotech employees and using biotechnologies in their current production process for purposes other than developing new products and processes are classified as biotechnology users.

Using this screening scheme allows to target and survey the right population and to attain the main objective of the biotechnology survey, i.e. to collect information on firms that use biotechnology to develop products and processes.

7.4 Measuring Biotechnology Employment

A large percentage of firms are involved in activities other than biotechnology. As a result, any given employee may be involved in multiple tasks, including those related to biotechnology. Consequently, more than the level of education, an employee's involvement in biotechnology activities better measures if he/she is classified as a full-time or part-time biotech employee or not. During the data collection, it was observed that the number of biotechnology employees in question 4b in the 2001 BUDS, was less than the sum of 4c and 4d (Appendix 4). And more often than not, this difference corresponded to the number of employees in production, finance, marketing and management. In other words, most respondents equate employment in biotechnology to research and clinical activities. This could potentially lead to an under-estimation of the number of employees dedicated to biotechnology. By using an activity-based accounting, we avoid this problem.

VIII Conclusion

From its beginning in 1996 with the "Survey of Biotechnology Use in Canadian Industries – 1996", to the 2001 Biotechnology Use and Development Survey, surveying biotechnology has evolved in many ways. First of all, the focus of the surveys has changed from investigating the use of biotechnologies to include the use of biotechnologies to develop new products and processes. Second, along this change in focus, have emerged new questions such as those related to intellectual property (IP) rights. Third, the definition of Biotechnology has been refined and international comparability, mainly between OECD countries, is now possible.

Measures of biotechnology activity have been developed. These allow for a better understanding of Biotechnology, not only as a set of techniques, but also as a means to develop new products and processes. NAICS codes where the use of Biotechnology is probable are now clearly identified.

The quality of the data is improving along common standards, allowing for comparability between the survey data and other data sources, be it national or international.

Whenever needed, appropriate adjustments to definitions and concepts were made to better capture the target population. For example, in selecting the respondents, the Gross Business Income (GBI) was used in conjunction with R&D expenditures and the number of employees. Likewise, innovative biotech firms were defined in terms of their use of biotechnologies to develop new products and processes (process innovation), rather than having new products on the market (product innovation).

Insights gained from the iteration of the biotech surveys have allowed a better understanding of both the extent and the intensity of biotechnology activities in Canada. The lessons learned will help improve upcoming surveys.

References

Laroche, Richard, 2001. Enquête sur les entreprises de biotechnologie 1997 : Méthodologie. Business Survey Methodology Division, Ottawa: Statistics Canada.

Lavigne, Nicolas, 2003. Enquête sur l'utilisation et le développement de la biotechnologie – 2001 : Rapport de méthodologie. Business Survey Methodology Division, Ottawa: Statistics Canada.

McNiven, Chuck, 2001(a). Biotechnology Use and Development Survey – 1999, Cat. No. 88F0006XIE No. 7, Science, Innovation and Electronic Information Division (SIEID), Ottawa: Statistics Canada.

McNiven, Chuck, 2001(b). Practices and Activities of Canadian Biotechnology Firms: Results from the Biotechnology Use and Development Survey – 1999, Cat. No. 88F006XIE No. 11, SIEID, Ottawa: Statistics Canada.

McNiven, Chuck, Lara Raoub and Namatié Traoré, 2003. Features of Canadian biotechnology innovative firms: Results from the biotechnology use and development survey – 2001, Cat. No. 88F0006XIE No. 5, Science, Innovation and Electronic Information Division (SIEID), Ottawa: Statistics Canada.

Morin, Yves, Richard Laroche and Nicolas Lavigne, 2001. Enquête sur le développement et l'utilisation de la biotechnologie 1999. Business Survey Methodology Division, Ottawa : Statistics Canada;

OECD\Eurostat, 1997. Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data, Paris : OECD\Eurostat.

OECD, 2003. Building Partnerships for Progress: Statistical Definition of Biotechnology. http://www.oecd.org/document.

Statistics Canada, 2002. Generalized Estimation System (GES), www.statcan.ca, gensyst@statcan.ca.

Statistics Canada, 1997. North American Industry Classification System. Cat. No. 12-501-XPE, Ottawa: Statistics Canada.

Statistics Canada, 1998. Quality Guidelines. Third Edition, Cat. No. 12-539-XIE, Ottawa: Statistics Canada.

Statistics Canada, 2002. Statistics Canada's Quality Assurance Framework. Cat. No. 12-586-XIE, Ottawa: Statistics Canada.

Statistics Canada, 2003. Statistics Canada Quality Guidelines. Fourth Edition – October 2003, Cat. No. 12-539-XIE, Ottawa: Statistics Canada.

Rose, Antoine, 2000. A challenge for Measuring Biotechnology Activities, in John de la Mothe and Jorge Niosi (eds), The Economic and Social Dynamics of Biotechnology, Kluwer Academic Publishers, Boston/Dordrecht/London.

Traoré, Namatié, 2001. Canadian Biotechnology Industrial Activities: Features from the 1997 Biotechnology Survey. Science, Innovation and Electronic Information Division (SIEID), Cat. No. 88F0006XIE No. 12, Ottawa: Statistics Canada.

How to order catalogued publications

These and other Statistics Canada publications may be purchased from local authorized agents and other community bookstores, through the local Statistics Canada offices, or by mail order to:

Statistics Canada
Dissemination Division
Circulation Management
120 Parkdale Avenue
Ottawa, Ontario
K1A 0T6

Telephone: 1(613)951-7277
National toll free order line: 1-800-700-1033
Fax number: 1-(613)951-1584 or 1-800-889-9734
Toronto Credit Card only (416)973-8018
Internet: stats@statcan.ca

Catalogued publications

Statistical publication

88-202-XIE Industrial Research and Development, 2003 Intentions (with 2002 preliminary estimates and 2001 actual expenditures)

88-204-XIE Federal Scientific Activities, 2002-2003[e] (annual)

88-001-XIE Science Statistics (monthly)

Volume 27

No. 1 Biotechnology Scientific Activities in Selected Federal Government Departments and Agencies, 2001-2002

No. 2 Scientific and Technological (S&T) Activities of Provincial Governments, 1993-94 to 2001-2002[e]

No. 3 Distribution of Federal Expenditures on Science and Technology, by Province and Territories, 2000-2001

No. 4 Biotechnology Research and Development (R&D) in Canadian Industry, 2000

No. 5 Industrial Research and Development, 1999 to 2003

No. 6 Estimates of total spending on research and development in the health field in Canada, 1988 to 2002[p]

No. 7 Research and development (R&D) personnel in Canada, 1991 to 2000

No. 8 Federal government expenditures on scientific activities, 2003-2004[p]

Volume 28

No. 1 Estimation of research and development expenditures in the higher education sector, 2001-2002

No. 2 Total spending on research and development in Canada, 1990 to 2003[p], and provinces, 1990 to 2001

No. 3 Distribution of federal expenditures on science and technology by province and territories, 2001-2002

Working papers - 1998

These working papers are available from the Science and Innovation Surveys Section of Statistics Canada, please contact:

Science and Innovation Surveys Section
Science, Innovation and Electronic Information Division
Statistics Canada
Ottawa, Ontario
K1A 0T6
Internet: http://www.statcan.ca/english/research/scilist.htm
Tel: (613) 951-6309

ST-98-01	A Compendium of Science and Technology Statistics, February 1998
ST-98-02	Exports and Related Employment in Canadian Industries, February 1998
ST-98-03	Job Creation, Job Destruction and Job Reallocation in the Canadian Economy, February 1998
ST-98-04	A Dynamic Analysis of the Flows of Canadian Science and Technology Graduates into the Labour Market, February 1998
ST-98-05	Biotechnology Use by Canadian Industry – 1996, March 1998
ST-98-06	An Overview of Statistical Indicators of Regional Innovation in Canada: A Provincial Comparison, March 1998
ST-98-07	Federal Government Payments to Industry 1992-93, 1994-95 and 1995-96, September 1998
ST-98-08	Bibliometric Analysis of Scientific and Technological Research: A User's Guide to the Methodology, September 1998
ST-98-09	Federal Government Expenditures and Personnel on Activities in the Natural and Social Sciences, 1989-90 to 1998-99[e], September 1998

ST-98-10 Knowledge Flows in Canada as Measured by Bibliometrics, October 1998

ST-98-11 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1987 to 1998[e], and by Province 1987 to 1996, October 1998

ST-98-12 Estimation of Research and Development Expenditures in the Higher Education Sector, 1996-97, November 1998

Working papers - 1999

ST-99-01 Survey of Intellectual Property Commercialization in the Higher Education Sector, 1998, February 1999

ST-99-02 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1988-89 to 1996-97, June 1999

ST-99-03 An Analysis of Science and Technology Workers: Deployment in the Canadian Economy, June 1999

ST-99-04 Estimates of Gross Expenditures on Research and Development in the Health Field in Canada, 1970 to 1998[e], July 1999

ST-99-05 Technology Adoption in Canadian Manufacturing, 1998, August 1999

ST-99-06 A Reality Check to Defining E-Commerce, 1999, August 1999

ST-99-07 Scientific and Technological Activities of Provincial Governments, 1990-1991 to 1998-1999[e], August 1999

ST-99-08 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1988 to 1999[e], and by Province, 1988 to 1997, November 1999

ST-99-09 Estimation of Research and Development Expenditures in the Higher Education Sector, 1997-98

ST-99-10 Measuring the Attractiveness of R&D Tax Incentives: Canada and Major Industrial Countries, December 1999

Working papers - 2000

ST-00-01 Survey of Intellectual Property Commercialization in the Higher Education Sector, 1999, April 2000

ST-00-02 Federal Government Expenditures and Personnel in the Natural and Social Sciences, 1990-91 to 1999-2000[e], July 2000

ST-00-03 A Framework for Enhanced Estimations of Higher Education and Health R&D Expenditures, by Mireille Brochu, July 2000

ST-00-04 Information and Communications Technologies and Electronic Commerce in Canadian Industry, 1999, November 2000

Working papers - 2001

ST-01-01 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1989 to 2000[e], and by Province 1989 to 1998, January 2001

ST-01-02 Estimation of Research and Development Expenditures in the Higher Education Sector, 1998-99, January 2001

ST-01-03 Innovation, Advanced Technologies and Practices in the Construction and Related Industries: Provincial Estimates, 1999, January 2001

ST-01-04 Innovation, Advanced Technologies and Practices in the Construction and Related Industries: National Estimates, 1999, February 2001

ST-01-05 Provincial Distribution of Federal Expenditures and Personnel on Science and Technology 1990-91 to 1998-99, February 2001

ST-01-06 Estimates of Total Expenditures on Research and Development in the Health Field in Canada, 1988 to 2000[e], March 2001

ST-01-07 Biotechnology Use and Development, 1999, March 2001

ST-01-08 Federal Government Expenditures and Personnel in the Natural and Social Sciences, 1991-92 to 2000-2001[e], April 2001

ST-01-09 Estimates of Research and Development Personnel in Canada, 1979 to 1999[e], June 2001

ST-01-10 Innovation in Canadian Manufacturing: National Estimates, 1999, June 2001

ST-01-11 Practices and Activities of Canadian Biotechnology Firms: Results from the Biotechnology Use & Development Survey -- 1999, August 2001

ST-01-12 Canadian Biotechnology Industrial Activities: Features from the 1997 Biotechnology Survey, September 2001

ST-01-13 Innovation in Canadian Manufacturing: Provincial Estimates, 1999, September 2001

ST-01-14 Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1990 to 2001[e], and by Province, 1990 to 1999, November 2001

ST-01-15 Estimation of Research and Development Expenditures in the Higher Education Sector, 1999-2000, December 2001

Working papers - 2002

ST-02-01	Innovation and Change in the Public Sector: A Seeming Oxymoron, January 2002
ST-02-02	Measuring the Networked Economy, March 2002
ST-02-03	Use of Biotechnologies in the Canadian Industrial Sector: Results from the Biotechnology Use & Development Survey - 1999, March 2002
ST-02-04	Profile of Spin-off Firms in the Biotechnology Sector: Results from the Biotechnology Use and Development Survey - 1999, March 2002
ST-02-05	Scientific and Technological Activities of Provincial Governments 1992-1993 to 2000-2001[e], April 2002
ST-02-06	Are we Managing our Knowledge? Results from the Pilot Knowledge Management Practices Survey, 2001, April 2002
ST-02-07	Estimates of Total Expenditures on Research and Development in the Health Fields in Canada, 1988 to 2001[p], May 2002
ST-02-08	Provincial Distribution of Federal Expenditures and Personnel on Science and Technology, 1991-92 to 1999-2000, May 2002
ST-02-09	An Overview of Organisational and Technological Change in the Private Sector, 1998-2000, June 2002
ST-02-10	Federal Government Expenditures and Personnel in the Natural and Social Sciences, 1992-1993 to 2001-2002[p], June 2002
ST-02-11	Innovation in the Forest Sector, June 2002
ST-02-12	Survey of Innovation 1999, Methodological Framework: Decisions Taken and Lessons Learned, June 2002
ST-02-13	Innovation and the Use of Advanced Technologies in Canada's Mineral Sector: Metal Ore Mining, July 2002
ST-02-14	Estimation of Research and Development Expenditures in the Higher Education Sector, 2000-2001, December 2002
ST-02-15	Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1991 to 2002[p], and by Province 1991 to 2000, December 2002
ST-02-16	Survey of Innovation 1999, Statistical Tables, Manufacturing Industries, Canada, December 2002
ST-02-17	Determinants of Product and Process Innovations in Canada's Dynamic Service Industries, December 2002

Working papers - 2003

ST-03-01	A Comparison of International R&D Performance: An Analysis of Countries That Have Significantly Increased Their GERD/GDP Ratios During the Period 1989-1999, February 2003
ST-03-02	Who's Sharing What With Whom? How Canadian Businesses Used Electronic Networks to Share Information in 2001, February 2003
ST-03-03	How is the Canadian Biotechnology Evolving: A Comparison of the 1997 and 1999 Biotechnology Use and Development Surveys, March 2003
ST-03-04	Scientific and Technological Activities of Provincial Governments, 1993-1994 to 2001-2002^{e}, March 2003
ST-03-05	Features of Canadian biotech innovative firms: results from the biotechnology use and development survey - 2001, March 2003
ST-03-06	Innovation is a social process, March 2003
ST-03-07	Knowledge management in practice in Canada, 2001, March 2003
ST-03-08	Provincial distribution of federal expenditures and personnel on science and technology, 1994-95 to 2000-2001, April 2003
ST-03-09	Federal government expenditures and personnel in the natural and social sciences, 1993-1994 to 2002-2003, April 2003
ST-03-10	Estimates of total expenditures on research and development in the health field in Canada, 1988 to 2002^{p}, November 2003
ST-03-11	Estimates of research and development personnel in Canada, 1979 to 2000, November 2003
ST-03-12	Survey of intellectual property commercialization in the higher education sector, 2001, November 2003
ST-03-13	Bioproducts development by Canadian biotechnology firms: findings from the 2001 Biotechnology Use and Development Survey, December 2003

Working papers - 2004

ST-04-01	Starting the new century: technological change in the Canadian private sector, 2000-2002, January 2004
ST-04-02	Estimation of research and development expenditures in the higher education sector, 2001-2002, January 2004
ST-04-03	Estimates of Canadian research and development expenditures (GERD), Canada, 1992 to 2003^{p}, and by province 1992 to 2001, January 2004

ST-04-04 The many guises of innovation: what we have learnt and where we are heading, 2003, January 2004

ST-04-05 Provincial distribution of federal expenditures and personnel on science and technology, 1995-96 to 2001-2002, February 2004

Research papers – 1996-2002

No. 1 The State of Science and Technology Indicators in the OECD Countries, by Benoit Godin, August 1996

No. 2 Knowledge as a Capacity for Action, by Nico Stehr, June 1996

No. 3 Linking Outcomes for Workers to Changes in Workplace Practices: An Experimental Canadian Workplace and Employee Survey, by Garnett Picot and Ted Wannell, June 1996

No. 4 Are the Costs and Benefits of Health Research Measurable?, by M.B. Wilk, February 1997

No. 5 Technology and Economic Growth: A Survey, by Petr Hanel and Jorge Niosi, April 1998

No. 6 Diffusion of Biotechnologies in Canada, by Anthony Arundel, February 1999

No. 7 Barriers to Innovation in Services Industries in Canada, by Pierre Mohnen and Julio Rosa, November 1999

No. 8 Explaining Rapid Growth in Canadian Biotechnology Firms, by Jorge Niosi, August 2000

No. 9 Internationally Comparable Indicators on Biotechnology: A Stocktaking, a Proposal for Work and Supporting Material, by W. Pattinson, B. Van Beuzekom and A. Wyckoff, January 2001

No. 10 Analysis of the Survey on Innovation, Advanced Technologies and Practices in the Construction and Related Industries, 1999, by George Seaden, Michael Guolla, Jérôme Doutriaux and John Nash, January 2001

No. 11 Capacity to Innovate, Innovation and Impact: The Canadian Engineering Services Industry, by Daood Hamdani, March 2001

No. 12 Patterns of Advanced Manufacturing Technology (AMT) Use in Canadian Manufacturing: 1998 AMT Survey Results, by Anthony Arundel and Viki Sonntag, November 2001

Appendix 1: Biotechnology Firm Survey – 1997

Science and Technology Redesign Project

Biotechnology Firm Survey - 1997

Confidential when completed.

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, Chapter S19.

Si vous préférez ce questionnaire en français, veuillez appeler à frais virés au (613) 951-9662.

In all correspondence concerning this questionnaire, please quote this four-digit reference number

Please correct name and address, if necessary

Purpose

Statistics Canada is undertaking this survey under the sponsorship of Industry Canada and BIOTECanada to produce information of use to firms engaged in biotechnology activities by adressing the following question: What are the main characteristics of the firms which choose to develop biotechnologies as an important component of their business? The information from the survey can be used by businesses for market analysis, by trade associations to study performance and other characteristics of their industries, by government to develop national and regional economic policies, and by other users involved in research or policy making. Statistics Canada will create a database combining survey responses with existing Revenue Canada and Statistics Canada records.

Confidentiality

While participation in this survey is voluntary, your cooperation is important to ensure that the information collected in this survey is as accurate and as comprehensive as possible. Statistics Canada is prohibited by law from publishing or releasing, in any manner, any statistics which would divulge information obtained from this survey that relates to any identifiable business without the previous written consent of that business. The data reported on the survey questionnaire will be treated in strict confidence, used for statistical purposes and released in aggregated form only. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other Legislation.

Biotechnology Definition

Biotechnology is defined as the application of science and engineering in the direct or indirect use of living organisms or parts of organisms in their natural or modified forms in an innovative manner in the production of goods and services or to improve existing processes.

Please report only on Canadian biotechnology activities of your company. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Questions?

If you require assistance in the completion of this questionnaire or have any questions regarding this survey please contact Lloyd Lizotte (tel: 613-951-2188 (call collect), fax: 613-951-9920 or e-mail: lizollo@statcan.ca)

Survey Contact

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name	Title
Telephone Number	Fax Number
___-___-____	___-___-____

Combined Report

1. If your records do not permit separate reporting, list the names of other companies included in this report and indicate whether they are engaged in biotechnology activities by writing YES or NO in the second column.

Name of company	Biotechnology activities YES or NO	Indicate type of affiliation with reporting company (i.e. parent, subsidiary or other)
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	
	1 ◯ Yes 2 ◯ No	

5-4900-40.1 1998-03-05 STC/SAT-465-75092

Statistics Canada Statistique Canada

Canada

Biotechnologies used by your firm

2. Please review the following list of biotechnologies, and check the applicable circle for each technology

Biotechnologies	Currently Used in Operations?	IF "YES" ▶ Principal Use *(check one only)*			IF "NO" ▼
		Products/ Processes Development	Clinical/ Field Trials	Current Production	Do you PLAN TO USE within 3 years?
DNA Based	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Genetic Engineering	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Gene Probes	2 ○ No ▶				1 ○ Yes 2 ○ No
Bio-informatics / Genomics / Pharmacogenetics	1 ○ Yes ▶	1 ○	2 ○	3 ○	
	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
DNA Sequencing / Synthesis / Amplification	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Gene Therapy	2 ○ No ▶				1 ○ Yes 2 ○ No
Biochemistry / Immunochemistry Based	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Vaccines / Immune Stimulants / Drug Design & Delivery / Combinatorial Chemistry	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Diagnostic Tests / Antibodies	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Peptide / Protein Sequencing or Synthesis	2 ○ No ▶				1 ○ Yes 2 ○ No
Cell Receptors / Cell Signalling / Pheromones / Three Dimensional Molecular Modelling / Structural Biology	1 ○ Yes ▶	1 ○	2 ○	3 ○	
	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Biosensors	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Biomaterials	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Microbiology / Virology / Microbial Ecology	2 ○ No ▶				1 ○ Yes 2 ○ No
Bioprocessing Based	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Cell / Tissue / Embryo Culture & Manipulation	2 ○ No ▶				1 ○ Yes 2 ○ No
Fermentation / Bioprocessing / Biotransformation / Bioleaching / Biopulping / Biobleaching / Biodesulphurization	1 ○ Yes ▶	1 ○	2 ○	3 ○	
	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Extraction / Purification / Separation	2 ○ No ▶				1 ○ Yes 2 ○ No
Bioremediation / Phytoremediation / Biofiltration / Bioindicators	1 ○ Yes ▶	1 ○	2 ○	3 ○	
	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
Natural Products Chemistry	2 ○ No ▶				1 ○ Yes 2 ○ No
Others (Please specify)	1 ○ Yes ▶	1 ○	2 ○	3 ○	
_____	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
_____	2 ○ No ▶				1 ○ Yes 2 ○ No
	1 ○ Yes ▶	1 ○	2 ○	3 ○	
_____	2 ○ No ▶				1 ○ Yes 2 ○ No

If your company does not presently use or plan to use any of the biotechnologies listed above, please stop here. Sign and return questionnaire. Thank you for your cooperation.

5-4900-40 1

BIO-INDUSTRY SECTOR

3. a) Please indicate the top 3 bio-industry sectors, where applicable, in numbered order, that best describe your firm's biotechnology activities. (use 1 for the Most important and 3 for the least important). Please also indicate the number of products based on genetic engineering (rDNA) your company has in each of the relevant development stages:

Human Health - Bio

1) **Diagnostics** (e.g. immunodiagnostics, gene probes, biosensors)
2) **Therapeutics** (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, drug delivery, combinatorial chemistry)
3) **Gene Therapy** (e.g. gene identification, gene constructs, gene delivery)

Bio-Informatics

4) **Genomics and Molecular Modelling** (e.g. DNA/RNA/protein sequencing & databases for humans,plants, animals and microorganisms)

Ag - Bio

5) **Plant Biotechnology** (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)
6) **Animal Biotechnology** (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)
7) **Biofertilizers/Biopesticides/Bioherbicides/ Biological Feed Additives/Microbial pest control** (e.g. bacteria, fungi, yeasts)
8) **Non-Food Applications of Agricultural Products** (e.g. fuels, lubricants,commodity and fine chemical feedstocks, cosmetics)

Food Processing

9) **Bioprocessing** (e.g. using enzymes and bacteria culture)
10) **Functional Foods/Nutriceuticals** (e.g. probiotics, unsaturated fatty acids)

Aquaculture

11) **Fish health** (e.g. diagnostics, therapeutics)
12) **Broodstock genetics** (e.g. tracking superior traits, genetic modification / engineering)
13) **Bioextraction** (e.g. karageenan from seaweed, antifreeze proteins from fish, flavours)

Mining/Energy/Petroleum/Chemicals

14) **Microbiologically enhanced petroleum/mineral recovery**
15) **(Cleaner) Industrial Bioprocessing** (e.g. biodesulphurization, bio-cracking, bio-recovery)

Forest Products

16) **Silviculture** (e.g. ectomycorrhizae, tissue culture, somatic embryogenesis, genetic markers, genetic engineering)
17) **(Cleaner) Industrial Bioprocessing** (e.g. biopulping, biobleaching, biological prevention of sapstain)

Environment

18) **Biofiltration** (e.g. treatment of organic emissions to air/water)
19) **Bioremediation and Phytoremediation** (e.g. cleanup of toxic waste sites using microorganisms)
20) **Diagnostics** (e.g. detection of toxic substances using bioindicators, biosensors, immunodiagnostics)

Other

21) **Custom synthesis- chemical or biological** (e.g. peptides, proteins, nucleotides, hormones, growth factors, biochemicals
22) **Other** (please specify)

Top Bio-sectors (1 to 3 by importance) Please write number and sub-headings from above list	Number of products by development stages		
	Approved/ On Market (number)	Clinical/Field Trial stage (number)	Under development (number)
1			
2			
3			

b) Did you implement a new or significantly improved **PROCESS** in the last 3 years that required the development of biotechnologies?

1 ◯ Yes ➤ How many? | Number |
2 ◯ No

c) Do you **PLAN** to implement in the NEXT 3 years a new or significantly improved **PROCESS** that requires the development of biotechnologies?

1 ◯ Yes ➤ How many? | Number |
2 ◯ No

Financial Information

4. **Total Business Activity (All activities including Biotech)**

a) Is your firm a public company? 1 ◯ Yes 2 ◯ No

b) Please report data for 1997 or the latest fiscal year available.
Do not include sales and operations of your **subsidiaries** located outside Canada.

Fiscal year (if different from 1997) ____

Balance Sheet	1997
Cash & securities	000$
Total Assets	000$
Total liabilities	000$
Shareholders Equity	000$

Revenue	1997
Product sales	000$
Contract Research	000$
Other revenue	000$

Expenses	1997
R&D	000$
All other expenses	000$

TOTAL Exports (as % of product sales)	%
Biotechnology Related Exports (as % of product sales)	%

Total exports to the United States (as % of product sales)	%
Total exports to Europe (as % of product sales)	%
Total exports to Asia (as % of product sales)	%
Total exports to South/Latin America (as % of product sales)	%
Total exports to other countries (as % of product sales)	%

Total number of employees (average for the year):			
What percentage of your product sales are based on biotechnology?	%	OR bio product sales	000$
What percentage of your R&D expenses are based on biotechnology?	%	OR bio R&D	000$

R&D

5. a) Did your firm have biotech R&D expenditures in any of the years 1995-1997?
1 ◯ Yes
2 ◯ No

b) In the past 5 years, did your company apply for the tax benefit under the R&D (SR&ED) tax programme?
1 ◯ Yes ➤ What was the most recent year? ____
2 ◯ No ➤ Why did your company not apply? *(check most important only)*
1 ◯ complexity of the application process
2 ◯ uncertainty of eligibility
3 ◯ did not meet eligibility requirements
4 ◯ other *(specify)* ____

Strategic Partnerships

6. Does your firm currently have any strategic alliances with other organizations *(a strategic alliance is a formal agreement with another firm to do business activities without merging)*

Strategic Alliance for:		Canadian Partner	Foreign Partner, (Please identify country of partner)				
			USA	E-U	Asia	South/ Latin America	Other
Marketing/Distribution	1 Yes ➤ 2 No	1	2	3	4	5	6
Manufacturing	1 Yes ➤ 2 No	1	2	3	4	5	6
Regulatory Affairs	1 Yes ➤ 2 No	1	2	3	4	5	6
Finance	1 Yes ➤ 2 No	1	2	3	4	5	6
Other	1 Yes ➤ 2 No	1	2	3	4	5	6
R&D Partnership:							
Biotech Company	1 Yes ➤ 2 No	1	2	3	4	5	6
Other company	1 Yes ➤ 2 No	1	2	3	4	5	6
University	1 Yes ➤ 2 No	1	2	3	4	5	6
Hospital	1 Yes ➤ 2 No	1	2	3	4	5	6
Research Institute	1 Yes ➤ 2 No	1	2	3	4	5	6
Federal Lab (Canadian)	1 Yes 2 No						
Provincial Lab (Canadian)	1 Yes 2 No						
Network of Centres of Excellence (Canadian)	1 Yes 2 No						

Human Resources engaged in Biotechnology Activities

7. a) In your current biotechnology activities, please give the number of employees on staff in the listed positions (include contract personnel and use fractions of a person-year if individuals are filling more than one role).

Position	Number Now Employed	Positions Unfilled Now	Estimated Number Employed in year 2001
R&D			
Clinical Affairs/Quality Assurance			
Regulatory/Legal/Government Affairs			
Manufacturing			
Marketing & Sales			
Business Development/Finance			
Administration/Human Resources			

Human Resources engaged in Biotechnology Activities (continued)

7. b) Does your firm have a formal employee development program (continuing education and training program)?

1 ◯ Yes ➤ If yes, estimate your firm's total expenditures on formal education and training in 1997? ($000) or as a percentage of product sales

2 ◯ No

$000 $ _____ OR _____ %

c) Does your firm employ co-op program students from universities?

1 ◯ Yes

2 ◯ No

d) Do you have a full time person solely responsible for Human Resources in your organization?

1 ◯ Yes

2 ◯ No

e) What is your approximate professional staff turnover rate (persons leaving as a % of total staff) for the biotechnology activity in 1997?

_____ %

f) Are you experiencing problems in recruiting Business Operations staff?

1 ◯ Yes ➤ If YES. In which specialties?

2 ◯ No

1 ◯ Finance
2 ◯ Marketing
3 ◯ Regulatory, Legal
4 ◯ Clinical Affairs

g) Are you experiencing problems in recruiting Technical / Production / Scientific / R&D staff?

1 ◯ Yes ➤ If YES. In which specialties?

2 ◯ No

1 ◯ Scientist
2 ◯ Engineering
3 ◯ Technicians

h) Have you tried to hire personnel from outside Canada in 1997?

1 ◯ Yes

2 ◯ No

▼

If Yes, From which areas?

1 ◯ US
2 ◯ EU
3 ◯ Asia
4 ◯ South/Latin America
5 ◯ Other

▼

If Yes, were you successful?

1 ◯ Yes

2 ◯ No ➤ If No, Was the problem related to the following issues?

1 ◯ Personal income taxes
2 ◯ Immigration Rules
3 ◯ Advancement opportunities
4 ◯ Other

Intellectual property (IP) instruments

8. a) Have you ever had to abandon an important biotech project because further work was blocked by IP rights held by another organization?

1 ◯ Yes ➤ Was this an issue of scope of patent in Canada as compared to other countries? 1 ◯ Yes 2 ◯ No

2 ◯ No

b) Has your firm been involved in litigation related to patent infringement in the past year?

1 ◯ Yes ➤ How many different cases? ____

2 ◯ No

c) During the last three years has your firm assigned the right to use intellectual property **TO**: *(check where applicable)*

	In Canada	Outside Canada
Another firm	1 ◯	2 ◯
Government lab	3 ◯	4 ◯
University	5 ◯	6 ◯
Hospital	7 ◯	8 ◯

d) During the last three years has your firm acquired the right to use intellectual property **FROM**: *(check where applicable)*

	In Canada	Outside Canada
Another firm	1 ◯	2 ◯
Government lab	3 ◯	4 ◯
University	5 ◯	6 ◯
Hospital	7 ◯	8 ◯

Problems for Biotechnology Commercialization in Canada

9. Select **the three** issues that you consider are the most important problems to successfully commercialize your biotechnology products/processes:

01 ☐ Access to capital

02 ☐ Access to smart capital (money plus management expertise)

03 ☐ Access to technology

04 ☐ Skilled human resources

05 ☐ Consumer acceptance

06 ☐ Lack of information about markets

Regulations:

07 ☐ Labeling

08 ☐ Limited international harmonization

09 ☐ IP protection

10 ☐ Cost for gaining regulatory approval

11 ☐ Time required to gain regulatory approval

12 ☐ Other *(please specify)* _____

Financing

10. a) Did you raise capital in 1997 for biotechnology?

1 ◯ Yes ➤ How Much? 000$

2 ◯ No

For what purposes?
(check most important)

1 ◯ R&D
2 ◯ Regulatory approvals
3 ◯ Process Scaleup
4 ◯ Other

Sources?
(check most important)

1 ◯ Friends / "Angel Investors"
2 ◯ Venture Capital / Labour Sponsored Funds
3 ◯ Private Placement
4 ◯ IPO (Initial Public Offering)
5 ◯ Secondary Public Offering
6 ◯ Strategic Alliance Partner
7 ◯ Other

b) Are you planning to raise capital in 1998?

1 ◯ Yes ➤ How Much? 000$

2 ◯ No

For what purposes?
(check most important)

1 ◯ R&D
2 ◯ Regulatory approvals
3 ◯ Process Scaleup
4 ◯ Other

Sources?
(check most important)

1 ◯ Friends / "Angel Investors"
2 ◯ Venture Capital / Labour Sponsored Funds
3 ◯ Private Placement
4 ◯ IPO (Initial Public Offering)
5 ◯ Secondary Public Offering
6 ◯ Strategic Alliance Partner
7 ◯ Other

Strategic Decisions

The following question should be answered by the CEO of your company.

11. As the CEO, what were the most important decisions you made over last year (1997)? For this year (1998)?
(check up to three for each year)

	1997	1998
Refocused current product development	01 ◯	02 ◯
Downsized the organization	03 ◯	04 ◯
Increased the size of the organization	05 ◯	06 ◯
Entered product trials	07 ◯	08 ◯
Launched new product	09 ◯	10 ◯
Acquired a company	11 ◯	12 ◯
Acquired by a company	13 ◯	14 ◯
Outsourced to others	15 ◯	16 ◯
Licenced in technology	17 ◯	18 ◯
Licenced out technology	19 ◯	20 ◯
Alliances with academia	21 ◯	22 ◯
Alliances with government	23 ◯	24 ◯
Alliances with companies	25 ◯	26 ◯
Raised private capital	27 ◯	28 ◯
Raised public capital	29 ◯	30 ◯
Raised $ from alliance	31 ◯	32 ◯
Raised $ from sales	33 ◯	34 ◯
Borrowed $	35 ◯	36 ◯
Other *(please specify)*	37 ◯	38 ◯

Comments

Thank you for your cooperation !

5-4900-40 1

Appendix 2: Biotechnology Use and Development Survey – 1999

Science, Innovation and Electronic Information Division

Biotechnology Use and Development Survey - 1999

Confidential when completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, c. S-19. Completion of the questionnaire is a legal requirement under the Statistics Act.

Si vous préférez ce questionnaire en français, veuillez cocher ☐

Survey Purpose

Statistics Canada is undertaking this survey in support of the Canadian Biotechnology Strategy. The purpose is to produce information about firms engaged in biotechnology activities by addressing the following question. What are the characteristics and activities of firms that use or develop biotechnology as an important part of their firm's activity?

Biotechnology is a dynamic emerging sector of the Canadian economy and its impact has the potential to be felt through all parts of Canadian society. An accurate understanding of biotechnology requires comprehensive data. Information from this survey may be used by businesses for economic or market analysis, by trade associations to study industry performance, government departments and agencies to assist policy formation, and the academic community for research purposes. Statistics Canada will create a database combining survey responses with existing Statistics Canada data records. **An executive summary of the results will be sent to all respondents**.

Please report on Canadian biotechnology activities of your firm. Complete a separate questionnaire for each firm engaged in biotechnology activity in Canada.

Authority

Collected under the authority of the Statistics Act, Revised Statutes of Canada, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Confidentiality

Statistics Canada is prohibited from publishing or releasing any statistics that would divulge information obtained from this survey that relates to any identifiable firm without the previous written consent of that firm. The data reported in this questionnaire will be treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the Statistics Act are not affected by either the Access to Information Act or any other Legislation.

If you require assistance in the completion of the questionnaire or have any questions regarding the survey, please contact:

Claire Racine-Lebel
Science, Innovation and Electronic Information Division
Statistics Canada
Tunney's Pasture
Ottawa, Ontario
K1A 0T6
Phone: (613) 951-6309 (please call collect) - Fax: (613) 951-9920
e-mail: Claire.Racine-Lebel@statcan.ca

Please indicate the name of the person completing this form so we know who to contact should we have questions about this report.

Name	Title
Telephone Number ___ - ___ - ____ Fax Number ___ - ___ - ____	Email

5-4900-500.1 2000-01-13 STC/SAT-430-75177

Statistics Canada / Statistique Canada

Canada

1 Biotechnologies

1. Please review the following list of biotechnologies and check the applicable circle or circles.

	Biotechnologies	Currently Used in Operations 0	If currently using, do you use them for: Product/Process Research & Development 1	Current Production 2	Environmental Purposes 3	Number of Years in Use 4	If No: Do you plan to use within 3 years 5
	DNA Based						
1110	Gene Probes/DNA Markers	○ Yes ○ No	○	○	○		○ Yes ○ No
1120	Bio-Informatics	○ Yes ○ No	○	○	○		○ Yes ○ No
1130	Genomics/Pharmacogenetics	○ Yes ○ No	○	○	○		○ Yes ○ No
1140	Genetic Engineering/DNA Sequencing/Synthesis/Amplification	○ Yes ○ No	○	○	○		○ Yes ○ No
	Biochemistry/Immunochemistry						
1150	Vaccines/Immune Stimulants	○ Yes ○ No	○	○	○		○ Yes ○ No
1160	Drug Design & Delivery	○ Yes ○ No	○	○	○		○ Yes ○ No
1170	Diagnostic Tests/Antibodies	○ Yes ○ No	○	○	○		○ Yes ○ No
1180	Peptide/Protein Sequencing/ Synthesis	○ Yes ○ No	○	○	○		○ Yes ○ No
1190	Cell Receptors/Signalling/ Pheromones/Structural Biology	○ Yes ○ No	○	○	○		○ Yes ○ No
1200	Combinatorial Chemistry/ 3D Molecular Modelling	○ Yes ○ No	○	○	○		○ Yes ○ No
1210	Biomaterials	○ Yes ○ No	○	○	○		○ Yes ○ No
1220	Microbiology/Virology/Microbial Ecology	○ Yes ○ No	○	○	○		○ Yes ○ No
	Bioprocessing Based						
1230	Cell/Tissue/Embryo Culture Manipulation	○ Yes ○ No	○	○	○		○ Yes ○ No
1240	Extraction/Purification/Separation	○ Yes ○ No	○	○	○		○ Yes ○ No
1250	Fermentation/Bioprocessing/ Biotransformation/Natural Products Chemistry	○ Yes ○ No	○	○	○		○ Yes ○ No
	Environment						
1260	Bioleaching/Biopulping/Biobleaching/ Biodesulphurization	○ Yes ○ No	○	○	○		○ Yes ○ No
1270	Bioremediation/Biofiltration/ Phytoremediation	○ Yes ○ No	○	○	○		○ Yes ○ No
	Other *(please specify)*						
1280		○ Yes ○ No	○	○	○		○ Yes ○ No
1290		○ Yes ○ No	○	○	○		○ Yes ○ No

→ **If you use at least one of the biotechnologies in Question 1 go to Question 3.**

→ **If you don't use any of the biotechnologies listed in Question 1 go to Question 2.**

2 Barriers to Using Biotechnologies

2. Rate the following factors' influence on your firm's decision **not** to use biotechnology. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

		Importance					
		Low				High	Not Applicable
		1	2	3	4	5	0
	Lack of Financial Justification						
2100	Small market size	○	○	○	○	○	○
2110	High cost of equipment	○	○	○	○	○	○
2120	High cost to implement/integrate biotechnology	○	○	○	○	○	○
2130	Cost of capital	○	○	○	○	○	○
	Human Resources						
2140	Shortage of skilled or trained staff	○	○	○	○	○	○
2150	Worker resistance	○	○	○	○	○	○
2160	Increased labour costs	○	○	○	○	○	○
	External						
2170	Government regulations	○	○	○	○	○	○
2180	Public acceptance/perception of biotechnology	○	○	○	○	○	○
	Technology						
2190	Biotechnology not sufficiently developed	○	○	○	○	○	○
2200	Lack of external technical expertise/support	○	○	○	○	○	○
	Other (*please specify*)						
2210		○	○	○	○	○	○

If you are not using any biotechnology, please stop here.
Please return the questionnaire in the return prepaid envelope.
Thank you for your co-operation

3 Information Sources on Biotechnology

3. Rate the importance of the following sources of information on biotechnology as used by your firm. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

	Sources of Information on Biotechnology	Importance Low 1	2	3	4	High 5	Not Applicable 0
3100	Internal resources/staff or parent/subsidiary firm	○	○	○	○	○	○
3110	Academic journals/trade publications	○	○	○	○	○	○
3120	Universities/colleges/private training institutes	○	○	○	○	○	○
3130	Federal government department/agency	○	○	○	○	○	○
3140	Personal contact with others (tacit knowledge)	○	○	○	○	○	○
3150	Other companies	○	○	○	○	○	○
3160	Provincial government department/agency	○	○	○	○	○	○
3170	Professional/industry associations	○	○	○	○	○	○
3180	Library/literature search	○	○	○	○	○	○
3190	Database retrieval services	○	○	○	○	○	○
3200	Conferences/workshops/trade shows	○	○	○	○	○	○
3210	Other (*please specify*)	○	○	○	○	○	○

4 Benefits from Using Biotechnology

4. a) Does your firm use biotechnology in its production or processing operations?

4100 ○ No ⟶ Go to Question 5.

○ Yes

b) Rate the benefits from using biotechnologies in your firm's production or processing operations. Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

	Benefit of Using Biotechnology	Importance Low 1	2	3	4	High 5	Not Applicable 0
	Productivity Improvement						
4110	Lower labour costs	○	○	○	○	○	○
4120	Lower capital costs	○	○	○	○	○	○
4130	Lower energy costs	○	○	○	○	○	○
	Product Improvement						
4140	Develop new products or processes	○	○	○	○	○	○
4150	Extend product range	○	○	○	○	○	○
4160	Improvement in product quality	○	○	○	○	○	○
	Plant Organization						
4170	Increase production flexibility	○	○	○	○	○	○
4180	Lower maintenance expenses	○	○	○	○	○	○
4190	Cleaner production/pollution reduction	○	○	○	○	○	○
	Market Performance						
4200	Improve market position	○	○	○	○	○	○
4210	Increase sales	○	○	○	○	○	○
4220	Reduced time to market/Faster delivery time	○	○	○	○	○	○
	Other (*please specify*)						
4230		○	○	○	○	○	○

5 Human Resources

For the purposes of this survey Employees are defined as those workers for whom you completed a Revenue Canada T4-Statement of Remuneration Paid Form for the 1999 tax year. Include working owner(s). Do not include students.

5. a) How many employees does your firm currently employ? ____ 5100

b) How many employees have biotechnology-related responsibilities? ____ 5110

c) In the table below provide the number of biotechnology employees. Class the employee by their primary area of responsibility. For example, a person working 60% of their time on biotechnology research would be counted once as mainly working in scientific/research direction.

	Position	Number Currently Employed		
		Working full-time on biotechnology (more than 50% of time) 1	Working part time on biotechnology (less than 50% of time) 2	Estimated number to be employed in biotechnology in 2002 3
	Biotechnology R&D Activities			
5120	Scientific/Research Direction			
5130	Technicians/Engineering			
5140	Regulatory/Clinical Affairs			
	Biotechnology Administration & Production			
5150	Production			
5160	Finance/Marketing			
5170	Management/Licensing/Administration			

d) Does your firm currently have unfilled full time biotechnology-related positions?

5180 ○ No ⟶ Go to Question 5 e)

○ Yes ↓

	Position	Number of Unfilled Full-Time Positions 1	If Yes, was the reason due to: Lack of qualified candidates 2	Compensation required by qualified candidated too high 3	Other 4
	Biotechnology R&D Activities				
5190	Scientific/Research Direction		○ 1	○ 2	○ 3
5200	Technicians/Engineering		○	○	○
5210	Regulatory/Clinical Affairs		○	○	○
	Biotechnology Administration & Production				
5220	Production		○	○	○
5230	Finance/Marketing		○	○	○
5240	Management/Licensing/Administration		○	○	○

e) Does your firm employ (either paid or unpaid) post-secondary students in biotechnology-related activities? Include co-op placements, part-time, and full-time positions.

5250 ◯ No ⟶ Go to Question 5 f)

◯ Yes ⟶ What level of education? ⟶ 1◯ Technical/Trade/College
2◯ Undergraduate level
3◯ Graduate level

f) Does your firm contract out any of the following biotechnology-related activities?

	Biotechnology Activity	No (0)	Yes	If yes, what is the value (in $000) of contracts in 1999? If more than one what is the total value? (1)
5260	Research & Development	◯	◯ ⟶	$,000
5270	Regulatory/Clinical Affairs	◯	◯ ⟶	$,000
5280	Marketing/Distribution	◯	◯ ⟶	$,000
5290	Management/Licensing/Administration	◯	◯ ⟶	$,000

6 Recruiting Practices

6. Check any of the following methods used to fill biotechnology-related positions.

6000
1◯ Internet resources
2◯ University recruitment
3◯ Use under-qualified staff
4◯ Temporary/contract staff
5◯ Employment agencies
6◯ In-house training
7◯ Use over-qualified staff
8◯ Networking
9◯ Newspaper/journal ads
10◯ Professional associations
11◯ Other (*please specify*) _____

7. a) Did you attempt to hire biotechnology staff from outside Canada in 1999?

6100 ◯ No ⟶ Go to Question 7 c)

◯ Yes ⟶ From where? ⟶ 1◯ USA 4◯ Latin America
2◯ Europe 5◯ Other
3◯ Asia

b) Were you successful in hiring biotechnology staff from outside Canada?

6120 ◯ No

◯ Yes ⟶ How many biotechnology staff did you hire from outside Canada in 1999? 1 ☐

c) Did biotechnology personnel leave your firm in 1999?

6130 ◯ No

◯ Yes ⟶ How many? 1 ☐

7 Product/Process Development

8. a) Is your firm currently **developing** product that **requires** the use of biotechnologies?

7000 ◯ Yes

◯ No

8. b) Is your firm currently **developing** processes that **requires** the use of biotechnologies?

7110 ◯ Yes

◯ No

c) Does your firm consider biotechnology central to its activities?

7120 ◯ Yes

◯ No

Did you answer "Yes" to any part of Question 8?

7130 ◯ Yes ⟶ Go to Question 9

◯ No ⟶ Please stop here. Return the questionnaire in the prepaid return envelope. Thank you for your cooperation.

8 Biotechnology Products

9. Please provide the **number** of biotechnology products or processes your firm has at each stage of development.

	Biotechnology Sector	Number of biotechnology products/processes by development stage			
		Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
	Human Health				
8110	**Diagnostics** (e.g. biosensors, immunodiagnostics, gene probes)				
8120	**Therapeutics** (e.g. vaccines, immune stimulants, biopharmaceuticals, rational drug design, drug delivery, combinatorial chemistry)				
	Agriculture Biotechnology				
8130	**Plant Biotechnology** (e.g. tissue culture, embryo-genesis, genetic markers, genetic engineering)				
8140	**Animal Biotechnology** (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)				
8150	**Non-food Agriculture** (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)				
	Natural Resources				
8160	**Energy** (e.g. microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulphurization)				
8170	**Mining** (e.g. microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulphurization)				
8180	**Forest Products** (e.g. biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing)				
	Environment				
8190	**Air** (e.g. bioremediation, diagnostics, phytoremediation, biofiltration)				
8200	**Water** (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
8210	**Soil** (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				

Biotechnology Products

	Biotechnology Sector	Number of biotechnology products/processes by development stage			
		Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
	Aquaculture				
8220	Fish health, broodstock genetics, bioextraction				
	Bioinformatics				
8230	**Genomics & molecular modelling** (e.g. DNA/RNA/ protein synthesising & databases for humans, plants, animals, and micro-organisms)				
8240	**Gene therapy** (e.g. gene identification, gene constructs, gene delivery)				
	Food Processing				
8250	**Bioprocessing** (e.g. using enzymes and bacteria culture)				
8260	**Functional Foods/Nutraceuticals** (e.g. probiotics, unsaturated fatty acids)				
	Other *(please specify)*				
8270					
8280					

9 Cooperative/Collaborative Arrangements

10. Was your firm involved in biotechnology-related **cooperative/collaborative arrangements** with other companies or organizations in 1999?
Cooperative and collaborative arrangements involve the active participation in projects by your company and other companies or organizations in order to develop and/or continue work on new or significantly improved biotechnology processes, products and/or services. Pure contracting-out is not regarded as collaboration.

9100 ◯ No ⟶ Go to question 13

◯ Yes ⟶ How many? ⟶ [ ] 1

11. Please indicate for which purposes. Check any that are applicable.

	Arrangement Purpose	
9110	To conduct research & development (R&D)/ Access to specialized inputs	◯
9120	Regulatory affairs	◯
9130	To access knowledge/skills/critical expertise	◯
9140	Prototype development/production/manufacturing	◯
9150	Access markets/distribution channels	◯
9160	Access to capital	◯
9170	Intellectual Property Protection	◯
9180	Other (*please specify*)	◯

12. Check collaboration/co-operation arrangements by each type and their geographic location.

	Partner Category	Canada 0	USA 1	Europe 2	Latin America 3	Asia 4
9190	A firm of smaller or equal size	○	○	○	○	○
9200	A larger firm	○	○	○	○	○
9210	Government department/agency	○	○	○	○	○
9220	University/Hospital/Research network	○	○	○	○	○
9230	Other (*please specify*)	○	○	○	○	○

13. Would you describe your firm as a 'spin-off'?
A Spin-off is defined as a new firm created to transfer and commercialize inventions and technology developed in universities, firms or laboratories.

9240 ○ No ⟶ Go to Question 14

○ Yes ⟶ Was your firm a spin-off from; ⟶
- 1 ○ University/hospital
- 2 ○ Another company
- 3 ○ Government agency/lab
- 4 ○ Other (*please specify*) _____

10 Obstacles to Biotechnology Commercialization

14. Rate the following **obstacles to advancement of biotechnology commercialization** activities in your firm.
Use the following scale where 1 is low importance and 5 is high importance. Indicate if not applicable to your firm.

		Importance Low 1	2	3	4	High 5	Not Applicable 0
	Inputs						
10100	Access to capital	○	○	○	○	○	○
10110	Access to technology/information	○	○	○	○	○	○
10120	Access to human resources	○	○	○	○	○	○
	Markets						
10130	Domestic market too small	○	○	○	○	○	○
10140	Lack of access to international markets	○	○	○	○	○	○
10150	Transportation regulations on biotechnology	○	○	○	○	○	○
10160	Lack of distribution & marketing channels	○	○	○	○	○	○
	Constraints						
10170	Public perception/acceptance	○	○	○	○	○	○
10180	Regulatory requirements	○	○	○	○	○	○
10190	Time/cost	○	○	○	○	○	○
10200	Patent rights held by others	○	○	○	○	○	○
10210	Lack of patent protection for plants	○	○	○	○	○	○
10220	Lack of patent protection for animals	○	○	○	○	○	○
10230	Lack of patent protection for human components (e.g., organs, tissues)	○	○	○	○	○	○
10240	**Other** (*please specify*)	○	○	○	○	○	○

11 Patents

15. a) How many patents and/or pending patents does your firm currently have in each region. (Indicate '0' if none).

		Geographic Location					
		None 5	Canada 0	USA 1	Europe 2	Latin America 3	Asia 4
11100	Existing patents						
11110	Pending patents						

b) Please indicate the number of **patent applications** your company submitted to the following Patent Offices. (Indicate '0' if none)

	Patent Office/Year	1998 0	1999 1
11130	Canadian Intellectual Property Office (CIPO)		
11140	United States Patent & Trademark Office (USPTO)		
11150	European Patent Office (EPO)		
11160	Other (*please specify*)		

c) Please indicate the number of applications for **plant breeders' rights** your company submitted. (Indicate '0' if none)

	Patent Office/Year	1998 0	1999 1
11170	Canadian Plant Breeders' Rights Office		
11180	Plant Variety Protection Office, USDA		
11190	Community Plant Variety Office, EU		
11120	Other (*please specify*)		

12 Intellectual Property

16. During the last two years, 1998-1999 did your firm **grant the right to use intellectual property** to another firm or did your firm **acquire the right to use intellectual property** from another firm?

12100 ◯ No ⟶ Go to Question 17

◯ Yes ⟶ Please indicate the type and direction of such intellectual property transfer.

	Intellectual Property	Granted Rights to Canadian Firms 0		Granted Rights to Foreign Firms 1		Acquired Rights from Canadian Firms 2		Acquired Rights from Foreign Firms 3	
		Yes	No	Yes	No	Yes	No	Yes	No
12110	Trade Secrets/Licensing Agreements	◯	◯	◯	◯	◯	◯	◯	◯
12120	Patents	◯	◯	◯	◯	◯	◯	◯	◯
12130	Plant breeders' rights	◯	◯	◯	◯	◯	◯	◯	◯

13 Revenues, Expenditures & Trade

17. Please provide financial details in the following table. Please report for fiscal years and in thousands of dollars ($,000's). Indicate "0" if none

		Please provide details in $,000's for the years		What is your forecast for 2002
		1998 (0)	1999 (1)	2002 (2)
13100	Total Firm Sales/Revenue	$,000	$,000	$,000
13110	% of Total Sales/Revenue From Biotechnology	%	%	%
13120	Total R&D Spending	$,000	$,000	$,000
13130	% of R&D Spending on Biotechnology R&D	%	%	%
13140	Total Exports (including licensing agreements)	$,000	$,000	$,000
13150	% of Exports from Biotechnology	%	%	%
13160	Total Imports	$,000	$,000	$,000
13170	% of Imports from Biotechnology	%	%	%

18. If your firm **exported** biotechnologies, what percentage (%) of biotechnology ***exports*** went to the following geographic locations in 1999? Include licensing agreements. What is your forecasted distribution for 2002?

	Year	Geographic Location				
		Canada (0)	USA (1)	Europe (2)	Latin America (3)	Asia (4)
13180	1999					
13190	Forecast for 2002					

19. If your firm **imported** biotechnologies, what percentage (%) of biotechnology ***imports*** came from the following geographic locations in 1999? Include licensing agreements. What is your forecasted distribution for 2002?

	Year	Geographic Location				
		Canada (0)	USA (1)	Europe (2)	Latin America (3)	Asia (4)
13200	1999					
13210	Forcast for 2002					

20. a) Did your firm attempt to raise capital for biotechnology in fiscal year 1999?

13220 ◯ No ⟶ Go to Question 20 c)

◯ Yes

b) Were you successful in raising capital?

13230 ◯ No ⟶ Go to Question 20 c)

◯ Yes ⟶ How much did you raise? (in thousands) ⟶ $,000

Indicate the sources of capital and the percentage (%) of total capital that source provided in 1999.

	Source	% of Total Capital
13240	Angel investors/family/friends	
13250	Government loans/grants/incentives	
13260	Venture Capital funds	
13270	Conventional sources (i.e. banks)	
13280	Initial Public Offering (IPO)	
13290	Collaborative alliance	
13300	Other *(please specify)*	
	TOTAL	**100%**

20. c) Does your firm plan to raise capital in 2002?

13310 ◯ No ⟶ Go to Question 21

◯ Yes ⟶ How much do you plan to raise in 2002? ⟶
1 ◯ Less than $500,000
2 ◯ $500,000 to $5,000,000
3 ◯ More than $5,000,000

21. In the past 5 years did your firm apply for the tax benefit for biotechnology related activities under the R&D (SRED) tax program?

13320 ◯ No ⟶ Why? ⟶
1 ◯ Complexity of application process
2 ◯ Uncertainty of eligibility
3 ◯ Did not meet eligibility requirements
4 ◯ Other (*please specify*) _____

◯ Yes

22. Does your firm use the Internet?

13330 ◯ No ⟶ Go to Question 23

◯ Yes ⟶ Indicate for what purposes your firm uses the Internet.
(Check any that are applicable.)

1 ◯ Sharing research & development
2 ◯ Marketing/selling
3 ◯ Purchasing goods and services
4 ◯ Accessing databases/information sources
5 ◯ E-commerce
6 ◯ Human resource search
7 ◯ Public relations
8 ◯ General communication
9 ◯ Other (*please specify*) _____

23. Which of the following strategies did your firm use in 1999?
(Check any that are applicable)

13400
1 ◯ Refocused product development
2 ◯ Downsized
3 ◯ Increased size
4 ◯ Entered product trials
5 ◯ Launched new product
6 ◯ Acquired a company
7 ◯ Out-source production
8 ◯ Licensed in technology
9 ◯ Licensed out technology
10 ◯ Merged with other company
11 ◯ Formed a joint venture
12 ◯ Expanded into foreign markets
13 ◯ No change
14 ◯ Other (*please specify*)

Comments

14100
If you have any comments regarding this survey, please provide them in the space below.

Thank you for your co-operation

Please return the questionnaire in the return prepaid envelope.

Appendix 3: Biotechnology Use and Development Survey – 2001; First phase questionnaire

Science, Innovation and Electronic Information Division

Biotechnology Use and Development Survey - 2001

Confidential once completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, Chapter S19. Completion of this questionnaire is a legal requirement under the Statistics Act.

Version française au verso

Information for the Respondent

Purpose of Survey

Statistics Canada is conducting this survey in order to develop information on biotechnology and related technologies such as functional foods, nutraceutical and bioproducts by identifying industry sectors where these activities take place. Please report on *Canadian activities of your firm in biotechnology, functional foods, nutraceutical or bioproducts*. Your firm may have responded to biotechnology questions in previous surveys, but there is also an increasing demand for information on other technologies and their impact on the Canadian economy.

Authority

Collected under the authority of the *Statistics Act*, Revised Statutes of Canada, 1985, Chapter S19. Completion of this questionnaire is a legal requirement under the *Statistics Act*.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the *Access to Information Act* or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection, and provide consistent statistics, Statistics Canada has entered into an agreement with the Institut de la Statistique du Québec, under Section 11 of the *Statistics Act*. Data collected from Québec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The *Statistics Act* of Quebec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

Instruction

A knowledgeable senior person in your firm, such as an R&D manager or production manager, can quickly complete this questionnaire. Please fill in the contact information below, answer all 3 questions and return the completed questionnaire in the accompanying self addressed prepaid envelope to Statistics Canada by March 7, 2002.

Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
7th floor, RHCoats Building
Statistics Canada

Telephone: 613-951-6309
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number (Area code) ___ - ___ - ____
Title	Fax number ___ - ____
Web address	E-mail

5-4900-505: 2001-01-24 STC/SAT-465-75330

Statistics Canada Statistique Canada

Canada

1. **Does your firm currently use or develop biotechnology in its activities?**

- ○ Yes
- ○ No

Examples of biotechnologies:

DNA genomics, pharmaco-genetics gene probes, DNA sequencing/synthesis/amplification, genetic engineering. Protein/peptide sequencing/synthesis, lipid/protein engineering, proteomics, hormones and growth factors, cell receptors/signalling/pheromones, cell/tissue culture, tissue engineering, hybridisation, cellular fusion, vaccine/immune stimulants, embryo manipulation, bioreactors, fermentation, bioprocessing, bioleaching, bio-pulping, bio-bleaching, biodesulphurization, bioremediation, biofiltration, gene therapy, viral vectors, bioinformatics, other.

2. **Does your firm currently make or develop functional foods or nutraceutical products?**

- ○ Yes
- ○ No

Functional food

is a conventional food, beverage, or ingredient enriched with functional components beneficial in disease prevention or disease-risk management, beyond basic nutritional functions. A food, beverage or ingredient may be made functional through a variety of means, such as the addition of components, extraction, fractionation, processing, plant or livestock breeding, livestock feeding techniques, genetic modification, other.

Nutraceutical

is a product isolated or purified from foods (includes herbs and botanicals) that is generally sold in medicinal forms not usually associated with food. A nutraceutical is demonstrated to have a physiological benefit or provide protection against chronic disease.

3. **Does your firm currently make or develop a bioproduct?**

- ○ Yes
- ○ No

Bioproduct

a commercial or industrial product (other than food and feed) made with biological or renewable domestic agricultural (plant, animal), marine or forestry materials, such as, bio-energy (heating and electricity), bio-fuels (ethanol and bio-diesel), biochemicals, fiberboard, textiles and bio-plastics, other.

Thank you for your cooperation

Please return the completed questionnaire
in the accompanying self addressed prepaid envelope

Appendix 4: Biotechnology Use and Development Survey – 2001; Second phase questionnaire

Science, Innovation and Electronic Information Division

Biotechnology Use and Development Survey - 2001

Confidential when completed

Collected under the authority of the Statistics Act, Revised Statutes of Canada, 1985, c. S-19.
Completion of the questionnaire is a legal requirement under the Statistics Act.

Si vous préférez ce questionnaire en français, veuillez cocher ☐

Information for the Respondent

Survey Purpose

Statistics Canada is undertaking this survey to produce a profile of firms engaged in biotechnology activities in Canada. The survey focuses on the characteristics and activities of firms that use or develop biotechnology as part of their company's activity.

Biotechnology is an emerging sector of the Canadian economy and its impact has the potential to be felt through all parts of Canada's society. An accurate understanding of biotechnology requires comprehensive data. Information from this survey may be used by businesses for economic or market analysis, by trade associations to study industry performance, government departments and agencies to assist policy formation, and by the academic community for research purposes. Statistics Canada may create a database by combining survey data with existing Statistics Canada data records.

Please report 2001 on Canadian biotechnology activities of your firm unless a specific question indicates otherwise. Complete a separate questionnaire for each company engaged in biotechnology activities in Canada.

Confidentiality

Statistics Canada is prohibited from publishing any statistics that would divulge information obtained from this survey that relates to any identifiable business, institution or individual. Data is treated in strict confidence, used for statistical purposes and released in aggregate form only. The confidentiality provisions of the *Statistics Act* are not affected by either the Access to Information Act or any other Legislation.

Federal-Provincial Agreement

In order to avoid duplication of enquiry, reduce the cost of collection and provide consistent statistics, Statistics Canada has entered into an agreement with the Institute de la Statistique du Québec. Under Section 11 of the Statistics Act data collected from Quebec firms in this survey will be transmitted to the Institut de la Statistique du Québec. The Statistics Act of Quebec includes the same provisions for confidentiality and penalties for disclosure of information as the Federal Statistics Act.

Who Should Complete This Questionnaire?

A senior manager, scientist/researcher or production manager should complete this questionnaire.

Assistance

If you have questions or require assistance please contact:

Claire Racine-Lebel
Science, Innovation and Electronic Information Division
Statistics Canada
Tunneys Pasture
Ottawa K1A 0T6

Telephone: 613-951-6309 (Call collect)
Fax: 613-951-9920
E-mail: Sieidinfo@statcan.ca

Please provide the following information:

Name of person completing this form	Telephone number Area code ( ) - ( ) - ( )
Title	Fax number ( ) - ( )
Web address	E-mail

5-5300-500 1 2002-02-06 STC/SAT-430-75177

Statistics Canada Statistique Canada

Canada

Section 1 - Biotechnologies in Use

This section measures the use of biotechnologies in your firm.

1. Using the table below, please indicate the use your firm makes of each type of biotechnology listed. Check the applicable circle or circles.

	Biotechnologies	Currently Used in Operation	If currently using, do you use them for			Number of Years in Use	If No ▼ Do you plan to use within 3 years?
			Product/ Process Development	Current Production	Environmental Purposes		
		0	1	2	3	4	5
	DNA - the coding						
1000	Genomics/Pharmaco-genetics	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1010	Gene probes	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1020	DNA sequencing synthesis amplification, Genetic Engineering	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
	Proteins and Molecules - the functional blocks						
1100	Protein/peptide sequencing/ synthesis	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1110	Lipid/protein engineering	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1120	Proteomics	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1130	Hormones, growth factors, pheromones	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1140	Cell receptors signalling	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
	Cell and Tissue Culture, and Engineering						
1200	Cell/ tissue culture, Embryo manipulation	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1210	Tissue engineering	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1220	Hybridization	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1230	Cellular fusion	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1240	Vaccine/immune stimulants	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
	Process Biotechnologies						
1300	Bioreactors	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					
1310	Fermentation, Bioprocessing	○ Yes → ○ ○ ○					○ Yes ○ No
		○ No →					

	Biotechnologies	Currently Used in Operation	If currently using, do you use them for: Product/ Process Development	Current Production	Environmental Purposes	Number of Years in Use	If No ▼ Do you plan to use within 3 years?
		0	1	2	3	4	5
1320	Bioleaching, Bio-pulping, Biobleaching, Biodesulphurization	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
1330	Bioremediation, Biofiltration	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
	Sub-Cellular Organisms						
1400	Gene Therapy	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
1410	Viral Vectors	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
	Other						
1500	Bioinformatics	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
1510	Nanobiotechnologies	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No
1520	Other, Please Specify: _____	◯ Yes → ◯ No	◯	◯	◯		◯ Yes ◯ No

If you use at least one of the biotechnologies listed in Question 1 ▶ **Go to Section 2**

If you do not use any of the biotechnologies listed in Question 1 ▶ **Please return the questionnaire in the accompanying prepaid return envelope.**

Thank you for your assistance.

Section 2 - The Effects of Biotechnology on Your Firm

This section measures the factors influencing the use of biotechnology in your firm and the impact of biotechnology use on your firm's performance.

2. Using the table below, please rate the level of influence of each factor on increasing your use of biotechnology.

		Importance				
		Low 1	2	3	4	High 5
	Inputs					
2000	Access to capital	○	○	○	○	○
2010	Access to technology/information	○	○	○	○	○
2020	Access to human resources	○	○	○	○	○
	Markets					
2100	Size of Domestic Market	○	○	○	○	○
2110	Access to international markets	○	○	○	○	○
2120	Information about markets	○	○	○	○	○
2130	Distribution & marketing channels	○	○	○	○	○
	Constraints					
2200	Public perception/acceptance	○	○	○	○	○
2210	Cost of regulatory approval	○	○	○	○	○
2220	Time required for regulatory approval	○	○	○	○	○
2230	Limited international harmonization	○	○	○	○	○
2240	Patent rights held by others	○	○	○	○	○
2250	Lack of protection for intellectual property	○	○	○	○	○
2260	Other, Please specify: _____	○	○	○	○	○

3. For each of the performance factors listed below, please rate the level of impacts of biotechnology use on your firm's performance.

		Importance				
		Low 1	2	3	4	High 5
	Increased Productivity					
3000	Labour costs	○	○	○	○	○
3010	Capital costs	○	○	○	○	○
3020	Energy costs	○	○	○	○	○
	Improved Products					
3100	New products or processes introduced	○	○	○	○	○
3110	Product range increased	○	○	○	○	○
3120	Product quality increased	○	○	○	○	○
	Knowledge Based					
3200	Developing new areas for R&D	○	○	○	○	○
3210	Increase efficiency for R&D	○	○	○	○	○
	Improved Market Performance					
3300	Market position improved	○	○	○	○	○
3310	New Market Niche Developed	○	○	○	○	○
3320	Sales increased	○	○	○	○	○
3330	Other, Please Specify: _____	○	○	○	○	○

Section 3 - Human Resources in Biotechnology

Concerns have been expressed about the availability of skilled biotechnology employees. Your cooperation in careful completion of this section is essential in developing an accurate understanding of human resources in biotechnology. For the purpose of this survey Employees are defined as those workers for whom you completed a Canada Customs and Revenue Agency T-4 statement for the 2001 tax year. Include working owners. Do not include students. Only count employees working in Canada. If '0' (zero) indicate '0'.

Number of Biotechnology Employees

4. **a)** How many employees does your firm employ in Canada? Please Report Typical Employment Level for 2001. 4000

b) How many employees have biotechnology-related responsibilities? Please Report Typical Employment Level for 2001. 4010

c) Full-time Biotechnology Employees
For each group listed below indicate how many are full-time biotechnology employees (50% or more of their time spent on biotech related activities)? If an employee fulfils more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of full-time
Scientific Research & Direction	4100
Technicians	4110
Regulatory/Clinical Affairs	4120
Production	4130
Finance/Marketing	4140
Management	4150
Other, Please Specify:	4160
Total Full-time employees	4170

Part-time Biotechnology Employees

d) For each group listed below indicate how many are Part-time biotechnology employees (less than 50% of their time spent on biotech related activities)? If an employee fulfils more than 1 duty, report their primary responsibility. Count each person only once. Please Report Typical Employment Level for 2001.

Position	Number of part-time
Scientific Research & Direction	4200
Technicians	4210
Regulatory/Clinical Affairs	4220
Production	4230
Finance/Marketing	4240
Management	4250
Other, Please Specify:	4260
Total Part-time employees	4270

e) Total Number of biotechnology employees.
Total full-time and part-time employees with biotechnology-related responsibility (Box 4170 + Box 4270) 4011 *This number must equal 4010 above.*

Recruiting Practices

5. a) Does your firm have unfilled biotechnology-related positions?

5000 ◯ No ▶ Go to question 5b

◯ Yes ▶ In the table below indicate the number of unfilled positions by category.

Position	Number of Unfilled Positions
Scientific Research & Direction	5100
Technicians	5110
Regulatory/Clinical Affairs	5120
Production	5130
Finance/Marketing	5140
Management	5150
Other, Please Specify: _____	5160
Total unfilled positions	5170

b) Did your firm attempt to recruit any biotechnology employees in 2001?

5200 ◯ No ▶ Go to question 8

◯ Yes ▶ Were you successful?

5300 ◯ No ▶ Go to question 6

◯ Yes ▶ How many did you hire? 5310 ____

c) What sources were successfully used in recruiting biotechnology staff?

5400 ◯ University Recruitment
5410 ◯ Temporary/Contract Staff
5420 ◯ Employment agencies/Headhunters
5430 ◯ Professional Associations
5440 ◯ Own Staff/Incentive program
5450 ◯ Other Biotechnology Firms
5460 ◯ Pharmaceutical Firms
5470 ◯ Newspaper/Journal
5480 ◯ Student Internship
5490 ◯ Internal Training of Staff

6. Please rate the impact of the following factors on your efforts in filling biotechnology-related vacancies.

	Factors	Importance Low 1	2	3	4	High 5
	Candidate Factors					
6000	Compensation requirements by candidates too high	◯	◯	◯	◯	◯
6010	Candidates unwilling to relocate	◯	◯	◯	◯	◯
6020	Lack of experience	◯	◯	◯	◯	◯
	Firm Factors					
6100	Capital/resources insufficient to attract candidates	◯	◯	◯	◯	◯
	External Factors					
6200	Lack of qualified candidates	◯	◯	◯	◯	◯
6210	Competition for qualified candidates	◯	◯	◯	◯	◯
6220	Other, Please Specify _____	◯	◯	◯	◯	◯

7. Did you attempt to hire biotechnology staff from outside of Canada in 2001?

7000 ◯ No ▶ Go to question 8

◯ Yes ▶ Was your firm successful in hiring from outside of Canada?

7010 ◯ No ▶ Go to question 8.

◯ Yes ▶ How many staff from outside Canada did you hire? 7020

8. Did any biotechnology personnel leave your firm in 2001?

8000 ◯ No ▶ Go to question 9

◯ Yes ▶ How many? 8010

Section 4 - Biotechnology Products

This section measures the development of new biotechnology products and processes by your firm.

9. a) Do you have biotechnology products/processes on the market?

9000 ◯ No ▶ Go to question 9b)

◯ Yes ▶ What year was the most significant product first introduced? 9010

b) Is your firm currently developing products that require the use of biotechnology?

9100 ◯ No ▶ Go to question 9c)

◯ Yes ▶ What year will the most significant of these products reach market? 9110

c) Is your firm currently developing processes that require the use of biotechnology?

9200 ◯ No ▶ Go to question 9d)

◯ Yes ▶ What year will the most significant of these processes be completed? 9210

d) Do you consider biotechnology central to your firm's activities or strategies?

9300 ◯ No

◯ Yes

e) **If you answered "Yes" to any Part of Question 9** ▶ **Go to Q10**

Otherwise ▶ **Please return the questionnaire in the accompanying prepaid return envelope.**

Thank you for your assistance.

10. In the table below, for each sector listed please indicate the number of biotechnology products or processes your firm currently has for each stage of development.

	Biotechnology Sector	Number of biotechnology products/processes by development stage			
		Research & Development 0	Pre-clinical trials/ Confined field trials 1	Regulatory phase/ Unconfined release assessment 2	Approved/ On market/In production 3
	Human Health				
10000	**Diagnostics** (e.g. biosensors, immunodiagnostics, gene probes)				
10010	**Therapeutics** (e.g. vaccines, immune stimulants, biopharmaceuticals)				
10020	**Drug Delivery**				
	Agriculture Biotechnology				
10100	**Plant Biotechnology** (e.g. tissue culture, embryogenesis, genetic markers, genetic engineering)				
10110	**Animal Biotechnology** (e.g. diagnostics, therapeutics, embryo transplantation, genetic markers, genetic engineering)				
10120	**Non-food Agriculture** (e.g. fuels, lubricants, commodity and fine chemical feedstocks, cosmetics)				
	Natural Resources				
10200	**Energy** (e.g. microbiologically enhanced petroleum recovery, industrial bioprocessing, biodesulphurization)				
10210	**Mining** (e.g. microbiologically enhanced mineral recovery, industrial bioprocessing, biodesulphurization)				
10220	**Forest Products** (e.g. biopulping, biobleaching, biopesticides, tree biotechnology, industrial bioprocessing)				
	Environment				
10300	**Air** (e.g. bioremediation, diagnostics, phytoremediation, biofiltration)				
10310	**Water** (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
10320	**Soil** (e.g. biofiltration, diagnostics, bioremediation, phytoremediation)				
	Aquaculture				
10400	Fish health, broodstock genetics, bioextraction				
	BioInformatics				
10500	**Genomics & molecular modelling** (e.g. DNA/RNA/protein synthesising & databases for humans, plants, animals, and micro-organisms)				
10510	**Gene therapy** (e.g. gene identification, gene constructs, gene delivery)				
	Food Processing				
10600	**Bioprocessing** (e.g. using enzymes and bacteria culture)				
10610	**Functional Foods/Nutraceuticals** (e.g. probiotics, unsaturated fatty acids				
10620	Other, Please Specify _____				

11. a) What is the total time required to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

11000 Years 11001 Months

b) What is the total cost to bring your principal biotechnology product or process from the initial development phase/proof of concept stage to the market? If still in pre-market stages provide an estimate.

11100 $,000

Section 5 - Business Practices

Contracting Out

12. a) Did your firm contract out biotechnology related activities in 2001?

12000 ◯ No ▶ Go to question 12d)

◯ Yes ▶ For each partner type listed below, please indicate the number and value of contracts for each group listed.

Partner Type	Number of Contracts 0	Total Value of Contract in 2001 for ($,000) — Purpose of Contract: R&D 1	Regulatory/ clinical 2	Management/ Production 3	Other 4
12100 Private Entities (C.R.O's / other Firms, etc)		$,000	$,000	$,000	$,000
12110 Public Entities (Universities / Government Labs.)		$,000	$,000	$,000	$,000

b) Did you contract out to organizations outside of Canada?

12200 ◯ No ▶ Go to question 13

◯ Yes ▶ For each organization listed below, please indicate the percentage (%) of your firm's total contracting out in 2001.

Organization	% of total contracting out
12300 Private research lab	%
12310 University/Hospital	%
12320 Government lab	%
12330 Other biotechnology firm	%
12340 Other, Please Specify: _____	%

c) Rate the level of importance of each of the following reasons on your decision to contract out.

Reasons for Contracting Out	Importance: Low 1	2	3	4	High 5
12400 Knowledge not available internally	◯	◯	◯	◯	◯
12410 Access outside scientific expertise	◯	◯	◯	◯	◯
Cost Reduction Related to:					
12420 R&D Activities	◯	◯	◯	◯	◯
12430 Regulatory/Clinical Affairs	◯	◯	◯	◯	◯
12440 Production	◯	◯	◯	◯	◯
12450 Precursor to a formal agreement	◯	◯	◯	◯	◯
12460 Reduce risk/exposure	◯	◯	◯	◯	◯
12470 Other, Please Specify: _____	◯	◯	◯	◯	◯

d) Does your firm **provide** contract services to other firms or organizations?

12500 ◯ No ▶ Go to question 13

◯ Yes ▶ For each type of contract services listed below, please indicate the number of contracts entered into in 2001 and the revenues received for each category.

	Contract Services	Number of contracts entered in 2001 (0)	Revenue received from this source in 2001 (1)
12600	Routine Lab services		$,000
12610	Specialized Lab services		$,000
12620	Production/manufacturing services		$,000
12630	Other, Please Specify: _____		$,000
12640	**Total**		$,000

Collaborative Arrangements

Cooperative and collaborative arrangements involve the active participation in projects between your company and other companies or organizations in order to develop and/or continue work on new or significantly improved biotechnology processes and/or products. **Pure contracting-out work is not regarded as collaboration.**

13. a) Was your firm involved in biotechnology-related cooperative/collaborative arrangements with other companies or organizations in 2001?

13000 ◯ No ▶ Go to question 14

◯ Yes ▶ Provide the number of arrangements by purpose and partner type

	Arrangement Purpose	Number of Arrangements by Partner Type			
		Biotech Firm (0)	Non-biotech Firm (1)	Academic Institution/ Hospital (2)	Government lab or agency (3)
13100	To conduct research & development (R&D)				
13110	Regulatory affairs				
13120	Access others' patents				
13130	Production/manufacturing				
13140	Access markets/distribution channels				
13150	Access capital				
13160	Access to Intellectual property from partner				
13170	Other, Please Specify _____				
13180	Total number				

Intellectual Property

14. a) Did your firm grant biotechnology related intellectual property (IP) rights to another firm?

14000 ◯ No ▶ Go to question 14b)

◯ Yes ▶ For each type of intellectual property instrument listed below please indicate the number of IP rights granted by country and the total income received from IP licensing in 2001.

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Revenue from IP licensing in 2001 3
14100 Licensing Agreement				$,000
14110 Patents				$,000
14120 Other, Please Specify _____				$,000

b) Did your firm obtain biotechnology related intellectual property rights from another firm?

14200 ◯ No ▶ Go to question 15

◯ Yes ▶ Complete the following table

Intellectual Property Instrument	Number with Canadian firms 0	Number with USA firms 1	Number with other country firms 2	Cost to your firm of obtaining IP in 2001 3
14300 Licensing Agreement				$,000
14310 Patents				$,000
14320 Other, Please Specify _____				$,000

15. a) Does your firm have biotechnology related patents or pending patents?

15000 ◯ No ▶ Go to question 16

◯ Yes ▶ How many?

Indicate the distribution of biotechnology related patents and pending patents your firm has by Patent Office

	Canadian Intellectual Property Office (CIPO) 0	U.S. Patent & Trademark Office (USPTO) 1	European Patent Office 2	Other 3
15100 Existing Patents				
15110 Pending Patents				

b) Provide the number of unique patent applications your company submitted in

	Number
15200 2000	
15210 2001	

Section 6 - Firm Characteristics and Financial Profile

Revenues and Research and Development (R&D) Expenditures

16. Please complete the following table. If information is not available please provide a carefully considered estimate. Report for fiscal years and in thousands of dollars ($,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 0	2001 1	2004 Forecast 2
16000 Total Firm Sales/Revenues (all sources)	$,000	$,000	$,000
16010 % of revenues from Biotechnology	%	%	%
16020 Total R&D spending	$,000	$,000	$,000
16030 Total spending on Biotechnology R&D	$,000	$,000	$,000
16040 % of Biotechnology R&D spending contracted out	%	%	%

17. Does your firm have sales of biotechnology products?

17000 ◯ No ▶ Go to question 18

◯ Yes ▶ What percentage of your sales of biotechnology products came from.

	%
Direct sales to consumers or distributors	17100
Products sold to other firms to be used as inputs	17110

Firm History

18. Is your firm a public firm?

18000 ◯ No ▶ Go to question 19

◯ Yes ▶ What year was the Initial Public Offering (IPO)? 18100

19. What year was your firm or spin-off established? 19000

20. Has your firm merged with another firm? (Include acquisition of another firm or by another firm)

20000 ◯ No ▶ Go to question 21

◯ Yes ▶ What year did the merge take place? 20100

21. Is your firm a subsidiary of a Multi-National Enterprise (MNE)?

21000 ◯ No ▶ Go to question 22

◯ Yes

22. a) Is your firm a spin-off? A spin-off is defined as a new firm created to transfer and commercialize inventions and technology developed in universities, firms or laboratories.

22000 ◯ No ▶ Go to question 23

◯ Yes ▶ Was your firm a spin-off from ▶

- ☐ 22100 University/hospital
- ☐ 22110 Another Biotech company
- ☐ 22120 Non-biotech firm
- ☐ 22130 Government Agency/lab
- ☐ 22140 Other, Please Specify

Raising Capital

A great deal of attention has focused on the ability of biotechnology firms to raise capital and the challenges of raising capital. Questions in this section are intended to collect information in order to address this critical issue facing the biotechnology sector.

23. a) Did your firm attempt to raise capital for biotechnology related purposes in 2001?

23000 ◯ No ▶ Go to question 23h)

◯ Yes ▶ Were you successful in raising capital?

23100 ◯ No ▶ Go to question 23c)

◯ Yes ▶ How much 23110 $,000

b) Did you reach your target?

23200 ◯ No ▶ Go to question 23c)

◯ Yes ▶ Go to question 23d)

23. c) What reasons did the **lender** give in limiting or refusing your request for capital?
Check all that apply.

Biotechnology product/process not sufficiently developed	☐ 23300
Biotechnology product line or portfolio limited in scope	☐ 23310
Insufficient specific management skills/expertise	☐ 23320
Capital not available due to market conditions	☐ 23330
Further product development or proof of concept required	☐ 23340
Lender does not fund development projects	☐ 23350
Other, Please Specify _____	☐ 23360

d) What sources provided funding?

	% of total raised from each source?
Canadian based Venture Capital	23400 %
American based Venture Capital	23410 %
Conventional sources (i.e. banks)	23420 %
Angel Investors/Family	23430 %
Government sources	23440 %
Other, Please Specify _____	23450 %

e) **For your most important biotechnology product or process,**
please indicate the **current** stage of development.

Stage of Development

R&D	◯ 23500
Pre-Clinical	◯ 23510
Clinical Trials	◯ 23520
Market Entry	◯ 23530

For your most important biotechnology product or process,
please indicate total spending since the beginning of development.

	Stage of Development	Total spending up to and including current stage
23600	R&D	$,000
23610	Pre-Clinical	$,000
23620	Clinical Trials	$,000
23630	Market Entry	$,000

For your most important biotechnology product or process,
please estimate the total amount of capital required to complete each stage,
as well as the total capital available.

	Stage of Development	Total additional capital required to complete stage 1	Total capital available to complete stage (include all committed funds) 2
23700	R&D	$,000	$,000
23710	Pre-Clinical	$,000	$,000
23720	Clinical Trials	$,000	$,000
23730	Market Entry	$,000	$,000

23. f) How long do you anticipate this capital (committed and on hand) lasting?

23800 ☐ Years 23810 ☐ Months

g) Why did you raise or attempt to raise capital? Indicate each category that applies to your firm

23900 ◯ R&D purposes/Expand R&D capacity
23910 ◯ Repay current investors
23920 ◯ Commercialize current R&D projects
23930 ◯ Clinical/regulatory expenses
23940 ◯ Develop production/manufacturing capability
23950 ◯ Other, Please Specify:

h) Do you plan on raising capital in 2002?

24000 ◯ No ▶ Go to question 24
◯ Yes ▶ How much do you plan to raise? ▶ <$1,000,000 ☐ 24010
$1,000,000-$5,000,000 ☐ 24020
>$5,000,000 ☐ 24030

Tax Incentives

24. a) Did your firm have biotechnology R&D expenditures in any of the previous 5 years?

24100 ◯ No ▶ Go to question 26
◯ Yes ▶ In the past 5 years did your firm apply for benefits for biotechnology related activities under the Scientific Research and Experimental Development (SR&ED) tax program?

24200 ◯ Yes ▶ How much did you apply for in 2001? 24210 $,000 ▶ Go to question 24b
◯ No ▶ Why?

Complexity of application process ☐ 24300
Uncertainty of eligibility ☐ 24310
Did not meet eligibility requirements ☐ 24320
Other, Please Specify: ☐ 24330

b) Have any of your SR&ED credits expired?

24400 ◯ No
◯ Yes

25. Did your firm apply for any provincial R&D tax benefit or incentive?

25000 ◯ Yes

◯ No ▶ Why did you not apply?

Complexity of application process	25100 ☐
Uncertainty of eligibility	25110 ☐
Did not meet eligibility requirements	25120 ☐
Other, Please Specify	25130 ☐

_____

Imports & Exports

26. Did your firm export biotechnology products?

26000 ◯ No ▶ Go to question 27

◯ Yes ▶ Please complete the following table. Report for fiscal years and in thousands of dollars ($,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 (0)	2001 (1)	Forecast for 2004 (2)
26100 Total Exports Revenues (all sources)	$,000	$,000	$,000
26110 % export revenues from Biotechnology	%	%	%
Regional Distribution			
26200 % export revenues to US	%	%	%
26210 % export revenues to Europe	%	%	%
26220 % export revenues to Asia	%	%	%
26230 % export revenues to other regions	%	%	%

27. Did your firm import biotechnology products?

27000 ◯ No ▶ Go to question 28

◯ Yes ▶ Please complete the following table. Report for fiscal years and in thousands of dollars ($,000's). If '0' (ZERO) please indicate, do not leave blanks.

	2000 (0)	2001 (1)	Forecast for 2004 (2)
27100 Total Import Expenditures (all sources)	$,000	$,000	$,000
27110 % import expenditures from Biotechnology	%	%	%
Regional Distribution			
27200 % import expenditures to US	%	%	%
27210 % import expenditures to Europe	%	%	%
27220 % import expenditures to Asia	%	%	%
27230 % import expenditures to other regions	%	%	%

Strategies Used in 2001

28. In the table below rate the significance of each of the following strategies on your firm's performance in 2001.

		Importance				
		Low 1	2	3	4	High 5
	Knowledge development strategies					
28000	Captured and used knowledge obtained from other industry sources such as industry associations, competitors, clients and suppliers	○	○	○	○	○
28010	Captured and used knowledge obtained from public research institutions including universities and government laboratories	○	○	○	○	○
28020	Used and updated databases of scientific information	○	○	○	○	○
28030	Developed firm policies and practices for knowledge/intellectual property protection	○	○	○	○	○
28040	Developed/encouraged staff education/upgrading	○	○	○	○	○
28050	Conducted an Intellectual Property Audit to ensure protection of products and processes at all stages of development	○	○	○	○	○
	Business strategies					
28100	Increased firm size through acquisition, merger or joint venture	○	○	○	○	○
28110	Downsized operations of the firm	○	○	○	○	○
28120	Entered product trials/adapted products or processes for increased market penetration	○	○	○	○	○
28130	Began new research & development project	○	○	○	○	○
28140	Expanded into foreign markets	○	○	○	○	○
28150	Other, Please Specify: _____	○	○	○	○	○

29 a) Does your firm develop, produce or sell **Living Modified Organisms** (LMO)?

> Living modified organism means any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology. A living organism means any biological entity capable of transferring or replicating genetic material, including sterile organisms, viruses and viroids.
>
> Source: Cartagena Protocol on Biosafety

29000 ○ No

○ Yes ▶ If yes, how many unique products based on living modified organisms does your firm have at each of the following stages?

Research & Development Stage	29100
Clinical/Regulatory stage	29110
Market stage	29120
Total	29130

b) Did your firm export living modified organisms in 2001?

29200 ○ No

○ Yes ▶ If yes, how many unique products based on living modified organisms did you export? _____ 29210

How many unique living modified organisms did you export to

United States	29300
Europe	29310
Other	29320

Comments 30000

_____

_____

_____

_____

_____

_____

_____

_____

Thank you for your assistance.

Return the questionnaire in the accompanying self addressed prepaid envelope.